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The Potential for Critical Social Inquiry Through Environmental Education in the Philippines

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The Potential for Critical Social Inquiry Through Environmental Education in the Philippines

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The rate and extent of deforestation in the Philippines is phenomenal. It has been estimated that in 1934, 17 million hectares of the Philippines' 30 million hectares were covered in forest (Asian Development Bank, pp. 13-14.) This figure had dropped to 10.5 million by 1969, and by 1993 it stood at 5.7 million. If one looks at old growth forests, where there is the greatest diversity of animal, plant, and insect life, then the figures are even more stark: In 1934, there were 11 million hectares of old growth forest; in 1969, 4.7 million; and by 1993, the figure had dropped to just 900,000 hectares. If deforestation were to continue at the rate at which it occurred between 1969 and 1993 (that is, 200,000 hectares per year,) all of the Philippines' forests—old growth and degraded—would be completely gone in less than thirty years.

No doubt due to the immense scale of the ecological disaster unfolding throughout the Philippines, there has been an explosion in the number of environmental NGOs in the country in recent years—some nine hundred by a recent count (Severino). One of those hundreds of local NGO's is the Philippine Eagle Foundation (PEF), an organization devoted to increasing the population of the extremely rare Philippine Eagle. I have had the opportunity to work on-and-off with the PEF over the past couple of years, and have recently been developing for them educational materials for use in Philippine schools, focusing on the interrelationships between people, the eagle, and the environment in the Philippines. In the following pages I present some background information on the project and then share a working draft of

sixteen interdisciplinary lessons on the current environmental situation in the Philippines for use in classrooms in the Philippines.

Background Information: The Philippine Eagle Foundation

In the early 1980's, it was estimated that the population of Philippine Eagles in the world numbered less than 500, and by the end of that decade, the number had declined to between 89 and 222; today only 64 eagles have been positively sighted, and 17 of these are in captivity.

In 1969, the Philippine government became involved in the plight of the eagle, concentrating at first on releasing captured birds and conducting basic research on the eagle. A number of interested people formed an organization to promote conserving the eagle population, and in 1987 this group re-organized itself into a private non-profit, non-stock organization, which later became known as the Philippine Eagle Foundation. Slowly they were able to increase their funding, from the private sector, local government, and international environmental organizations. With increased funding they were able to increase programs, including adopt-a-nest projects, tree planting by schoolchildren, habitat monitoring, and "socio-economic programs" in the uplands.

During this period they were also increasing their technical knowledge and skill in captive breeding techniques, and in 1992 the first Philippine eagle was born in captivity; a year later, a second eagle was hatched. The media attention which these successes brought led to an increase in donations. Corporations such as Shell, Caltex, and Del Monte sought to associate themselves with the center, through donations and through positions on the

center's board of directors, as a way to associate their corporate names with environmental projects.

The main work of the PEF can be divided between their scientific efforts to understand and breed the Philippine eagle, and their efforts to educate and mobilize people on issues surrounding the environment. On the technical side, activities include captive breeding techniques, both natural pairing and artificial insemination, and field operations, such as monitoring nest sites, habitat evaluation, prey census, other data collection. Their environmental education programs, involving formal, non-formal, and informal education efforts, and targeting both adults and school children, have the goal of increasing public awareness on conservation issues. (Philippine Eagle Foundation, *Strategic Action Plan.*)

I first became involved with the Philippine Eagle Foundation as a teacher at a school in Manila. I visited the Foundation's breeding center in the southern Philippine island of Mindanao and was later able to bring a group of students there on a field trip. I was impressed with the PEF's approach to the environmental problems in the Philippines, as summed up in their mission statement on a plaque at the breeding center:

> The Philippine Eagle Foundation believes that the fate of the vanishing Philippine Eagle, the health of our environment, and the quality of Philippine life are inextricably linked. We are therefore fully committed to promote the survival of the Philippine Eagle, the biodiversity it represents, and the sustainable use of our forest resources for future generations to enjoy.

In the summer of 1995, I was able to return to the Philippines, live at the breeding center, and work as a volunteer with the Foundation for a number of months. What evolved out of that collaboration with the members of the

Foundation was a project to develop environmental education materials which could be used in classrooms in the Philippines. Since returning to Massachusetts, I have been working on a collection of lessons which will serve as an initial working document to be used in the process of developing an environmental education curriculum. The lessons are designed to be appropriate to the context in the Philippines and to help serve the goals of the PEF in the process.

"Problems" and "Solutions"

The extreme environmental situation in the Philippines has generated quite widespread attention on such environmental issues as deforestation, farming methods, pollution, biodiversity loss, and climate change. How one defines a problem, however, affects how one views possible solutions. To take one simple illustration: If activists perceive the environmental problems in the Philippines to be due to a lack of legal protections, they might focus all their energies on enacting laws to protect the environment without taking into consideration the reality that if the social, political, and economic conditions preclude enforcement of the laws, then little will have changed.[1] In fact, it might be argued that by drawing so much attention to the legal battle without focusing debate on other questions surrounding power and wealth, a legal approach would actually serve as a steam-valve, drawing off the energy of those concerned about the environment while preserving the status quo.

Some people have argued that the root cause of the environmental crisis in the Philippines is fundamentally a problem of education. This argument

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[1] It has been estimated, for example, that "In the Philippines, the illegal timber trade may amount to four times the size of the legal trade." (*Saving the Forests: What Will It Take?* World Watch Paper 117, Dec 1993, p. 40.)

takes many forms. One view suggests that individuals (farmers using inappropriate farming techniques and city dwellers throwing rubbish in the streets being two frequently sited examples of ignorance,) cause environmental degradation because they have incomplete or incorrect knowledge. Narrowly defining the problem in this way points directly to the solution of providing an education which will remove ignorance and replace it with correct knowledge.

Another view of the problem sees the root cause in inappropriate, incorrect values—that is, people are selfish and do not respect nature. There have been innumerable newspaper columns, radio hosts' speeches, conversations in taxis around the problem of a "Filipino culture" which is seen to be fundamentally ill with the diseases of selfishness, corruption, laziness, complacency, and so on. Seeing the problem as one of diseased values leads one to see the solution to ecological problems in an education which will promote proper values. Largely this seems to be carried out in didactic signs and slogans (e.g., "Don't be a smoke-belcher!" or "Manila—Clean and Green!") and simple moralistic textbook lessons on the need to value nature and stop littering.

There is another argument, less widespread in the predominantly Catholic Philippines than in other countries (notably in developed western countries,) which sees the problem in the Philippines to be essentially one of overpopulation. In this view of the crisis, there are simply too many people for the natural resources available in the country; in other words, nature in the Philippines has reached its so-called "carrying capacity." The solution is education, again to remove ignorance (teaching the lesson that "Having many children is a burden,") and to promote better values ("It is morally proper to have small families.")

Yet another view of the problem sees the root cause of the crisis to be poverty in the abstract; poverty creates ignorance, promotes bad values, and encourages environmental degradation. Environmental protection is seen as a luxury item, something which becomes important only after a certain level of development has been achieved. Poverty, in this view of the world, is seen as something which is the result of, again, an abstract "underdevelopment," and the solution is national development. Pres. Ramos' vision of the future, Philippines 2000, promotes the Philippines as the newest Asian Tiger, or Newly Industrialized Country. Through the industrialization which capital investment from other more-highly developed countries will bring, Filipinos will leave the farms and become highly-paid wage-workers in new industries. The poor are poor (and hence ignorant and hence destructive of the environment) because they are marginalized—in other words, because they exist outside of the modern, national economy.[2] A common variation on this view, especially among NGO's in the Philippines, sees the solution in the promotion of "alternative livelihoods," such as the encouragement of organic vegetable farming for the lucrative Manila upscale market.

Such views were apparent in the words of one of the corporate donors to the PEF, the president and CEO of Shell in the Philippines, when I asked him what he believed was "the root cause" of the environmental problem in the Philippines:

> The basic principles which Shell adheres to are those of what one now calls "sustainable development." You develop things in such a way

[2] This view ignores the fact that the poor already exist as integral players in the national economy. Jim Stormes has written that "The policy cure for poverty caused by marginalization is generally the 'integration' of the poor into the economy and the labor market. If the poor are educated and trained, or if barriers of discrimination are removed, or if full-employment policies are instituted, then the poor can be integrated into the economy and everyone will be better off. But there is an assumption here that the poor can disappear from their 'old,' marginal activities with little or no effect on the economy." (p. 80).

which does, whether you like it or not, does in the end influence, have an impact on the environment. If you do that in such a way that your children's children will not see the damage of that. So that you are indeed creating a situation where you have the sustainable position. That's the basic guideline. Now we know that at Shell, our operations, we try to, as good as we can, we try to have our operation work that way, but we also realize that there is an enormous gap in this society here about knowledge. What this means? For the Philippine Eagle Foundation is not just breeding the Philippine Eagle, eh? A large part is also educating the people in the Mindanao area, in the Bukidnon area, on not cutting forest, and that is essential to the chances of the survival of the Philippine Eagle and people are now aware of it, and there are now regions there in Mindanao where people are very concerned about it, local people, and where all the livelihood projects give them other sources of income than they had in the past. So this is a much broader issue, which is why we have gone quite strongly into education. (Willems, 1995)

Modernist Causation, Post-Modernist Alternatives

Over the course of working with the PEF, I found myself struggling with what I might call a modernist construction of causality. It seemed to me that there were indeed fundamental root causes of environmental degradation in the Philippines (as in other parts of the world,) root causes which lay in unequal political power and the control of wealth and resources which were inevitable with capitalism. I was concerned that an environmental group (such as the Eagle Foundation, but including other groups as well, international and domestic,) might focus their energies so completely on a narrow conservationist program (for example, the captive breeding of an endangered species such as the Philippine Eagle,) that attention would be drawn away from what I saw as the larger social, cultural, political, and economic issues of which environmental degradation was just a part. I debated what the PEF's role should be. Wouldn't a more purely or directly political movement for radical social change be the only defensible and

effective strategy for the PEF? Could narrow conservationist goals really help to limit the spread of injustice, misery, and inequity? Could they do just the opposite, serving to distract or drain off potentially explosive social movements, serving as a steam-valve for the discontent of those most affected by the destruction of the environment, leaving underlying causes either completely untouched or actually better positioned to extend exploitation?

I was pleased to see that among many members of the group which I worked with, there was a strong awareness of the kinds of issues which I was concerned with. When I asked one of the PEF people who works with peasant farmers what he felt the "root cause" of the environmental problem was in his country, he answered: "It is systemic. It's rooted in economic and social conditions of the people, no? Of course... landlessness, poverty.... People are forced to go up, follow the roads constructed by the loggers, because they have no land in the lowlands. Most of the lands have already title, no?" (Estrada.)

But in the course of thinking about what role education and environmental activism should play in the political, social, and economic struggles which I feel are necessary in the Philippines, I found myself enmeshed in a difficult tautological knot, which, of course, others have struggled with also: Do material conditions create ways of thinking, or do ways of thinking change material conditions? If material conditions (for example, the material modes of production, in orthodox Marxist discourse,) take primacy over, for example, the power of ideas to bring about social change, then intervention in the cycle becomes problematic, because if intervention in material conditions is necessary in order to change the way people think, how can one intervene to change material conditions without first having a dramatic shift in the way people think? And if the opposite is

true—if one can simply use the power of persuasion, of language and culture to bring about dramatic change—what then happens to the notion (in Althusser or Foucault, for example,) that ideas, philosophies, value systems, discourse in general is history- and context-bound?

Working through such notions in more of a post-modernist framework of overdetermination[3] helped me to accept the value and the potential of using educational work and environmental activism as legitimate contributions to the multiple, overdetermined "causes" of social change. What I found myself arguing for was an educational program which would not focus solely on the eagle, or the protection of the forests, or the development of the poor, or the promulgation of superior farming techniques, or any other "single root cause" view of the problem of environmental destruction in the Philippines. Whereas I began the project with the tendency to believe that environmental work in the Philippines (or the US for that matter,) was somewhat of a doomed project, a program of misdirected idealism or plain ignorance, what I have come to believe is that environmental education can serve a very useful role if it can help to encourage people to see the complex connections between what happens with the environment and what happens in other ongoing social processes.

The diagram on page 14 illustrates just a few of the complex interlocking webs of causes and effects which must be taken into consideration when attempting to understand the situation in the Philippines—and when

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[3] The term, borrowed from Freud, Lucás, and Althusser, and modified by Resnick & Wolff, "involves a distinctive notion of causality characteristic of Marxian theory. If all possible entitities are overdetermined, none is independent of any of the others. Moreover, each entity will have a different, particular relation to every other entity. Each entity only exists as—or, is caused or constituted by—the totality of these different relations with all other entities." (Resnick & Wolff, p. 4.)

attempting to construct an environmental education curriculum which will help students (whether children or adults) to critically reflect on the large social repercussions of just one aspect of the environmental crisis in the Philippines today, deforestation. (The placement of deforestation in the center of the diagram is an arbitrary decision, and any number of other concepts could occupy that slot. Similarly, any number of arrows could be drawn in any direction on the diagram.)

The Lessons

The first twelve lessons I developed were what I would consider to be "safe" lessons. Largely concerned with teaching environmental topics in an interdisciplinary and hopefully thoughtful manner, they deal with concepts and skills which any science teacher might already include in their curriculum without feeling pressure from local politicians or landowners. In the later lessons, I have attempted to write lessons on some issues which are crucial to understanding the broader context of the environmental situation, but which are more controversial topics—topics such as land ownership, access to resources, the "overpopulation" argument, bio-diversity vs. cash-crops, and so on. The challenge was to try to create useful, practical lessons around these topics which could be acceptable in Filipino classrooms, yet which would spur students and teachers to examine critically these important issues.

So often, people working in universities come to conclusions about what should be done, but paint their conclusions in such broad strokes, leaving actual detailed plans up to others to fill in, that one is left asking: "But how would you apply that? What would it look like?" What I have tried to do in

these lessons is not just say what should be done, but actually try to do it—to write practical lessons which could be used immediately in a classroom, or which could serve as a real-life model or provocation for others to develop lessons which might look more critically at such issues than traditional lesson plans propose. Whether these lessons are successful or not, the process of developing them has proved to be a challenge greater to me than writing a more traditional academic thesis.

The Context of the Philippine Classroom

Lessons created without a sense of the reality of the context of where they are to be applied don't stand a good chance of success, so a few words are in order about what a lesson "appropriate to the Philippine classroom" means.

The Department of Education in the Philippines has mandated that environmental education be taught in all schools, and it has largely fallen to science teachers to teach the subject. Textbooks tend to emphasize, therefore, the "scientific" aspect of environmental studies (for example, chapters on genetics; toxic waste; global warming through increasing production of carbon dioxide; destruction of the ozone layer and the need to stop using fluorocarbons.) Chapters in textbooks also tend towards the pedagogical model of presenting factual information and then testing how well the information has been memorized. When lessons extend beyond this model, and require some higher level of thinking, they tend to be tacked on at the end of chapters without much guidance to teachers on how to get the most out of them (for example: "Write a letter to your local newspaper about global warming.") Finally, some teachers have complained that textbook chapters are often general rather than specific to the Philippine context; if the

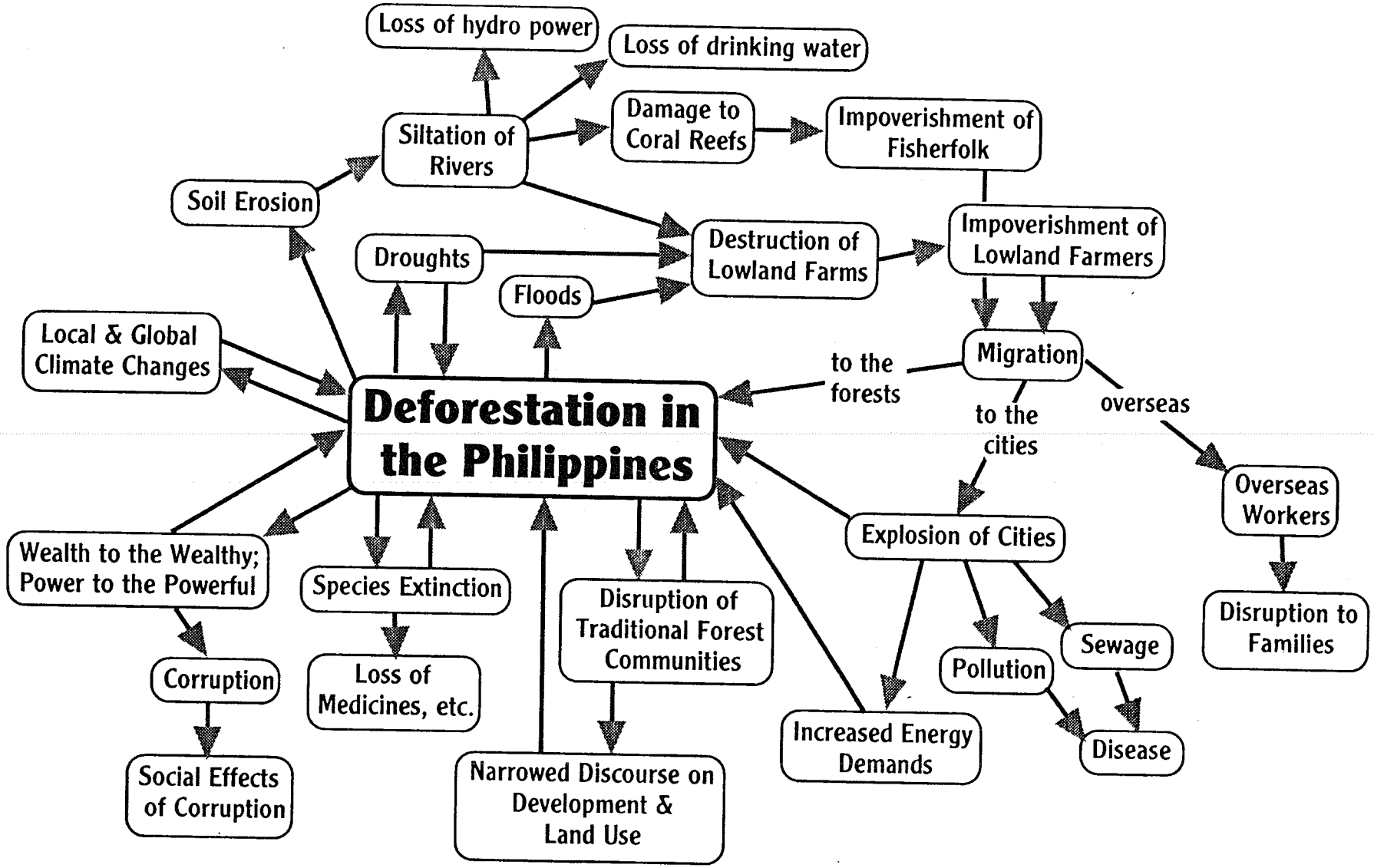
Philippine situation is mentioned, it tends again to the fact-recall model (for example, a laundry list of the environmental laws in the Philippines, or a list of the endangered species in the Philippines.) If there are chapters which look at bigger connections (for example, the disruption of an ecosystem,) they rely on examples from other countries (for example, the destruction brought by the construction of a dam in Egypt,) and offer the information without providing teachers with various methods of presenting the material.

The lessons presented here, then, were developed with a number of interlocking, related, and sometimes contradictory goals in mind. It was my intention that the lessons should:

- Be immediately useful to a classroom teacher (and here a detailed, thoughtful teacher's guide would be essential.)
- Be applicable in a classroom which does not have access to extensive educational supplies.
- Be applicable with large groups of students.
- Be complementary to other content (skills and concepts) which the teacher must cover.
- Form a bridge between different disciplines (e.g., math, biology, and map-reading) to encourage a more complex view of human knowledge.
- Require a degree of critical thinking, including constructing and testing hypotheses, evaluating evidence, and so on.
- Have students as much as possible think as the experts in various field do.

Where Does the Project Go From Here?

I recognize that there are thousands of teachers in classrooms throughout the Philippines who are teaching environmental studies in a multitude of effective ways, and I would not feel comfortable using these lessons to impose certain ways of teaching on them. The educational team of the PEF and I envisioned, therefore, that these lessons and teacher's guide would become a starting point for teacher study circles in Mindanao. Our intention is that these books simply become a focal point for a series of workshops involving teachers from various schools in the area—rural, urban, private Catholic, public, wealthy, poor. We have received a modest grant to cover the cost of printing these draft lessons and teachers' guides, and the first such workshop will take place as a weekend retreat at the Malagos Breeding Center in Mindanao in the spring of 1996. Twenty to twenty-five teachers will gather to discuss how they teach environmental studies, their successful strategies and lessons, the areas where they feel they need help or resources, and so on. This group will then meet again, after a period of perhaps six weeks, for another retreat where they will be able to discuss changes attempted, give feedback on experimental lessons, suggest revisions, and so on. Eventually, it is hoped that these experiences will be transformed into a much longer Eagle Workbook, based on the lessons and experiences of this first core group of teachers.


Deforestation in the Philippines
Loss of hydro power
Loss of drinking water
Siltation of Rivers
Damage to Coral Reefs
Impoverishment of Fisherfolk
Soil Erosion
Droughts
Floods
Destruction of Lowland Farms
Impoverishment of Lowland Farmers
Local & Global Climate Changes
Migration
to the forests
to the cities
overseas
Overseas Workers
Disruption to Families
Explosion of Cities
Wealth to the Wealthy; Power to the Powerful
Species Extinction
Disruption of Traditional Forest Communities
Corruption
Loss of Medicines, etc.
Sewage
Pollution
Disease
Increased Energy Demands
Social Effects of Corruption
Narrowed Discourse on Development & Land Use

The Philippine Eagle Workbook

Teacher's Guide

lessons on the interrelationship of the eagle, the environment, and people for the Philippine classroom

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With the assistance, guidance, and support of the Philippine Eagle Foundation, Inc., and the Ecological Society of the Philippines.

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Introduction

Teachers throughout the country have been given the job of teaching their students about the environmental situation in the Philippines, a situation which has reached disastrous proportions. All too often, though, teachers' materials have been either too general and not geared specifically for the Philippine context, or have been largely built upon a "lecture, memorize, test" model.

To help counter these problems, the lessons in this workbook are designed to
- present up-to-date information about the Philippine environment
- provide teachers with immediately usable lessons using a minimum of materials
- challenge students to think rather than memorize
- link disciplines across the curriculum
- complement, not replace, the current curriculum

The lessons use as a focal point the Philippine Eagle—its biology, habitat, and behavior. The eagle is now the national bird of the Philippines and many students have an emotional attachment to the bird, especially after the dramatic births of Pag-Asa and Pagkakaisa, the first tropical eagles bred in captivity after decades of research and hard work. It has become a symbol of the endangered environment and our attempts to protect it. Throughout the book, however, the emphasis is on the connection between the **eagle**, the **environment**, and the **people** of the Philippines. "Saving the eagle" would be an empty victory if environmental degradation and a worsening human condition were to continue.

A Few Words About Using Inquiry in the Classroom:

Many of the lessons in the workbook require students to construct a logical hypothesis based on a given problem. There are many ways to run such an exercise. One method (based upon the Inquiry Technique of Richard Suchmann,) is described below. But why should a teacher use such a technique? Inquiry is a teaching method which is useful for a number of reasons:

- Thinking like an expert. It has been shown that critical thinking and problem-solving, by and large, can not effectively be taught as an abstracted cognitive skill separate from a specific arena of expertise (for example, a chess master may not inherently make a good military general.)

- Theory of Knowledge. Inquiry can help students understand that our knowledge is built up through the investigation of mysteries; that knowledge in books is created knowledge and often just a best guess; that the same kind of hypothesis-building and testing that they are taught in their physical science classes goes on in the investigation of other areas of knowledge. It teaches them how to construct hypotheses from data and how to construct questions which can test those hypotheses.

• Building interdisciplinary links. Understanding which draws upon various fields of knowledge and forms of investigation and explanation is more in-depth, useful, and effective than narrowly-constructed expertise zones. The student who can draw in their knowledge and skills from various subjects sees them as real-world applications, sees how they inter-relate in the web of understanding the human world.

• It's fun. It's unpredictable. Everyone loves a puzzle.

• It's social. It relies upon teamwork and socially-constructed knowledge.

Caveats:

• The Inquiry Technique is not the single Silver Bullet which will slay all the evils in your classroom. It can't be used every day and it can't replace all other teaching techniques. It's just one tool in the toolbox—but it's a good one.

• If it becomes merely a form of 20 Questions, one of the most important elements of the technique will be lost, that is, the sense that the students are constructing as realistically as possible (given the constraints of any particular classroom or school environment) the hypotheses and questions for testing the hypotheses.

One Approach to Running an Inquiry-Based Lesson:

The lessons in the workbook can be presented in whatever way the teacher finds most useful for his or her particular context. One approach involves presenting a puzzling piece of information to the class, and then allowing them to investigate the puzzle in groups, following these **Rules of Inquiry**. (For a detailed, step-by-step description of this approach, see Chapter Six below.)

Rules of Inquiry

1. Some information is given to you; gather additional information by experimentation and/or by asking the teacher questions. All questions should be in answerable with "Yes" or "No."
2. Anyone may ask a question, if you raise your hand and are called on.
3. One person from each group should record the answers to the questions that come up. This helps you to review the information that has already been given.
5. You may discuss the problem with your group ONLY when a "caucus" has been called. Each caucus lasts two minutes.
6. Anyone may call a caucus, in order to discuss possible hypotheses or questions to prove or disprove another group's hypothesis.
7. A caucus must be called if your group thinks it has the solution to the problem. Your hypothesis goes on the board and then other groups try to think of questions to test that hypothesis.

Chapter One: "Oral History: Environmental Changes in Your Community"

An oral history project is the first chapter in this package of lessons on the environment in the Philippines, because it is important that we all understand what large changes have been taking place in our own neighborhoods—our own barrios, our own barangays, and to our own families. It's especially hard to understand historical change when you're young; life seems to change so slowly, it seems that things are the same now as they have always been. Or the other attitude is also common: If things were different in the past, then they must have been worse, and today's world is the best of all possible worlds ("Ma, you didn't even have color TV?") An investigation of local oral history helps to counter these two misconceptions.

An oral history project allows students to be genuine researchers, uncovering previously unrecorded information. The information which they gather can help as a point of reference, a foundation from which connections can be made to the rest of the material in this book. An oral history projects can serve to give recognition and value to the knowledge and experiences of older generations, no matter what level of schooling or travel or wealth they have attained. If the student comes from one of the indigenous cultural communities of the Philippines, the oral history they gather may help to actually preserve traditional practices threatened by "modern" values. And, not incidentally, these traditional practices have often proved to be much more protective of the environment than the materialist and individualistic practices which mark so much of modern life.

An oral history project is easy, flexible, and fun, and with a little coordination can involve teachers from different subjects who might otherwise not work together (for example, Composition and Science teachers.) The material gathered can be presented in a variety of ways: simple oral reports to the class; dramatizations for the whole community; artwork; production of small books. The use of such skills as careful listening, note-taking, and asking follow-up questions, as well as whatever skills are drawn upon in the presentation (such as public speaking, painting and drawing, dramatizing,) ensures that the project will bring benefits across the curriculum.

Before beginning the lesson, you may want to discuss with the class their view of such terms as "history," "fact," and "evidence." How do people's experiences become "history"? What makes a piece of information a "fact"? What information becomes news in the newspaper? Can each student think of a piece of information that they know to be true which they believe should have been in the news, but wasn't? Why wasn't it? You can divide the class into small groups and have them come up with examples and definitions, and report back after ten minutes to the rest of the class.

You may want to discuss the differences between primary sources (evidence which comes directly from someone who witnessed an event,) and secondary sources (evidence or information which comes to us from people who were not there to witness the event.) There are sophisticated issues involved and you should stress that neither type of source is automatically more reliable than the other. For example, poor memory or personal interest in deliberately distorting reality can make primary sources untrustworthy.

As a positive lead-in to the oral history project, emphasize that no matter how unreliable some people's memories of their past may be, there is a place in the history of our community for the voices of ordinary people.

Chapter Two: "Deforestation in the Philippines"

1. The "grid method" for approximating area on a map involves placing a grid of squares, drawn on thin tracing or onion skin paper, over a map. All filled squares are counted as one. Squares that are half- or more than half-filled are also counted as full squares. Squares less than half-filled are not counted at all. Students do not all need to use the same size squares, as long as each student's squares are consistent in size. The smaller the squares, the more accurate the approximation (though the counting is also more tedious and time-consuming.)

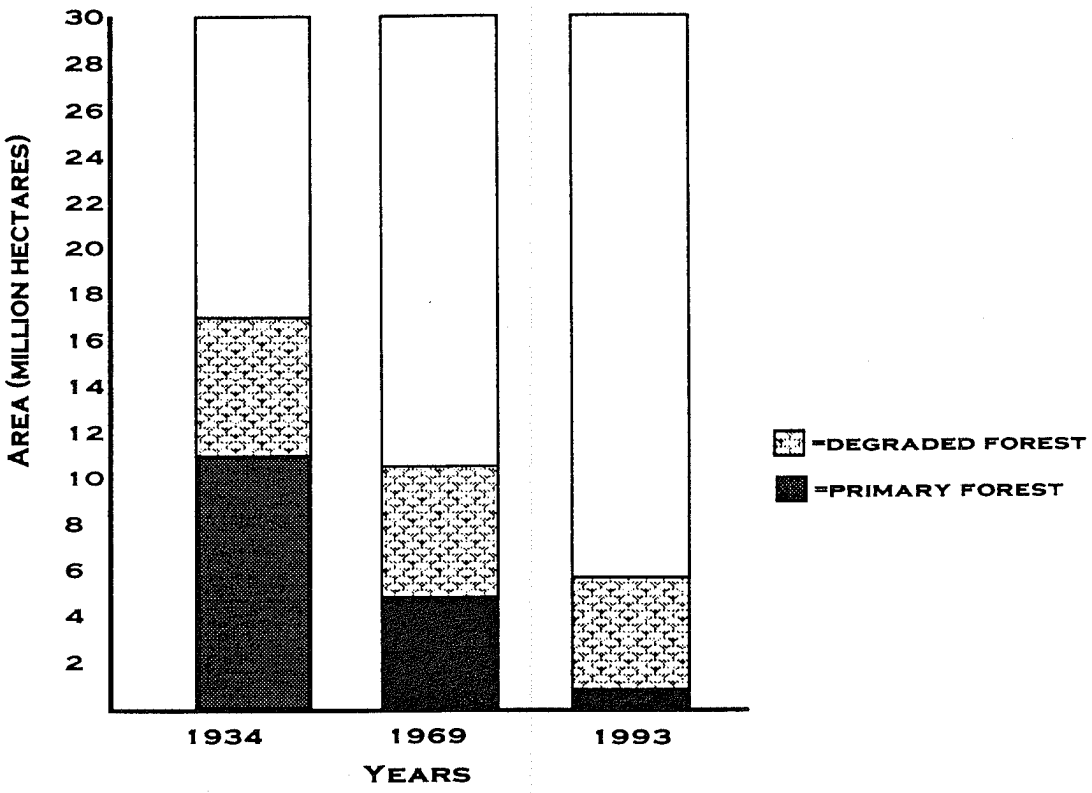
For this exercise, students should count the total number of squares (X), and the number of squares of forest cover (Y). then the percentage area of forest cover can be calculated using the following formula (other formulae are possible):

$$\frac{\text{area of forest}}{\text{total area}} = \frac{Y}{X} \times 100\% = \text{percentage of forest cover}$$

An accurate approximation will fall between 9% and 11%.

The actual area forested equals 97,923 km^2 (total area) divided by 9,740 km^2 (primary forest cover,) or 9.95%.

2. One possible graph might look like this:



Possible reasons which the students might give for inaccuracy in their predictions might include:

- the remaining forest cover is more inaccessible than already deforested lands, so the rate may slow down;
- population pressures are increasing, so the deforestation rate may speed up;
- the logging ban and effects of reforestation efforts may slow the rate;
- the growing scarcity of trees may drive up the price, making logging more profitable, causing the rate to speed up.

3. The graphs are misleading because they use different units for the vertical scales: The deforestation graph uses millions of hectares for the unit on its vertical scale, while the reforestation graph uses a unit of hundred-thousands. This has the effect of making the rate of reforestation relative to deforestation appear much higher than it is in reality. A single, less-misleading graph will show the actual rates of cutting and planting trees in their proper proportion.

A final note on the use of statistics in reforestation: Some agencies and organizations include the planting of **all** tree species in their statistics on reforestation, including the planting of commercial tree species such as coffee or cacao. Clearly, commercial tree plantations are not the same as renewed forests.

Chapter Six: "The Philippine Eagle Egg Mystery"

The following lesson requires students to create and test hypotheses to solve a perplexing puzzle: Why the Philippine Eagle's egg gets lighter as it incubates. (Actually, all birds' eggs have this characteristic.) Hypotheses are built in stages, with more information available to the students at each stage. In the process, the students learn (or apply already learned knowledge) about the biology of bird reproduction; respiratory gas exchange; and the relationship between the rate of evaporation and humidity. They also come to appreciate the difficult and exacting work of the biologists who work to breed the Philippine Eagle in artificial conditions. Forming the class into teams encourages a healthy competition to figure out the solution, and encourages cooperation among team members. A short "Check for Understanding" assignment at the end of the lesson can be given separately to each student to see if individuals have understood the lesson.

Materials Needed:

The lesson can be taught using only the student workbook, but it will be more effective if the following can be provided:

Fragments of egg shells (chicken eggs are fine)
Microscopes or hand lens
Fertile chicken eggs at various stages of development
Candles for seeing the inside of the eggs

Procedure:

1. Form the students into teams of four. They should be able to form a comfortable circle for discussion, and one should be a note-taker, recording the hypotheses the group considers.
2. Ask teams to discuss and then guess whether the weight of an incubating Philippine eagle egg (a) stays the same; (b) increases; or (c) decreases over the course of incubation (approximately 60 days.) Ask them to provide a reason for their answer. One person from each group reports back to the class as a whole. Typically, students guess that the egg's weight stays the same because an egg is a completely enclosed object.
3. Tell them that over the course of incubation, the egg actually loses approximately 15% of its weight. Ask each team to come up with hypotheses to explain this unexpected fact.
4. Distribute the fragments of chicken eggs if available. Ask them to study the shells (under microscopes if available, or with magnifying glasses,) and to revise and add to their hypotheses.
5. Each team presents to the teacher a written list of their hypotheses, in the order of "most likely" to "least likely." When all groups are finished, one representative from each group explains its top hypothesis and the thought process which led the group to arrive at it (i.e., the reasons, arguments, evidence.) The teacher should list all hypotheses as they are presented, and, after they are all on the board, lead a discussion of reasons (generated by the students) why some of the hypotheses are not likely to be true.
6. Finally, the teacher presents the solution to the puzzle by asking the students to open their workbooks and read Chapter 6—make sure no one looks in the book before this

point or the solution will be given away. At the end of the reading is a short "Check for Understanding" which each student should complete on their own.

Additional Teaching Aids:

a) Place an uncooked chicken egg in a glass container and pour enough clear corn syrup into the container to completely cover the egg. Leave the egg for 72 hours. The egg will be very odd-looking, and you should allow the students to open up the egg. The water in the egg will have passed through the semi-permeable eggshell; the molecules of syrup are too large to pass through, so the egg becomes dehydrated. This can be done at the end of the lesson above, and you can ask the students to use their new knowledge about eggs to explain what has happened to the egg, or you can have each team perform the experiment as they are constructing their hypotheses about the 15% weight loss during incubation. (If you have students perform the experiment remember that they will have to put the eggs in syrup three days beforehand.)

b) To demonstrate the idea of semi-permeability to those who still need convincing, take a balloon, put a couple of drops of vanilla extract inside, blow up the balloon, and place it in a box with a lid which can be closed tightly. Students sniff inside the box when the balloon is first placed inside and should not be able to smell the vanilla. The box is closed tightly, and set aside for a short time. Students should then be able to open the lid and smell the vanilla. This is possible because the molecules are small enough to pass through the rubber membrane of the balloon.

Solution to "Check for Understanding"

First, the student needs to create a chart similar to the one shown in the workbook, preferably on graph paper. The vertical axis should be marked in grams, not percentages, to make calculations easier. Then the student should calculate what the hatching weight of the egg should be at the end of the incubation period–in other words, to calculate 85% (100%-15%) of the initial weight of 190g (161.5g.) A straight line should be drawn from the 100% (190g) mark to the 85% (161.5g) mark on the students' charts. Since the weight of the bird on the 50th day (175g) is higher than it should be (above the line drawn on the graph,) the student should deduce that conditions for the egg are too humid (i.e., not enough water has evaporated from the egg,) and therefore recommend that the humidity be reduced. In the incubation room this would be accomplished by turning on a dehumidifier. (You may want to include a short description of how a dehumidifier works.)

Possible follow-up exercise: "Why Are Eggs Egg-Shaped?"
Provide small groups of students with a table-tennis ball and a chicken egg. The spherical ball represents those birds, like owls, who lay their eggs in holes in hollow tree trunks. Generally, round eggs are laid in holes where there is little risk of them rolling away. More pointed eggs, like that of the murre, usually belong to birds who lay eggs on cliff ledges–the pointed shape helps to prevent the egg from rolling away.

Chapter Seven: "Imprinting: HE's Your Husband?!"

This chapter presents information about one of the more fascinating aspects of captive breeding of endangered birds: the relationship which develops between humans and birds.

An interesting follow-up, after reading the chapter, would be to do a role-playing game, drawing upon the observation skills of the students. Divide the class in two and separate the two groups so they can not hear or see the other half. For one half of the exercise, group A is an exotic, little understood and endangered species; group B is a group of natualists sent to study the group and gain their confidence by copying the proper behavior to be accepted into group A. In the second half of the exercise, the roles are reversed.

Each group must devise elaborate behavioral rules which governs their particular "species." If this will take too long, you can create the rules beforehand. The behavioral rules should be relatively complex to make the job of understanding and being accepted by (becoming "imprinted" on) the foreign species more challenging. For example:

- When walking around the room, make strong eye-contact with the person nearest you, but when communicating with someone, avoid eye-contact.
- "Talk" to each other by set patterns of hand-clapping (eg, the first person always speaks with an even number of claps, and the second always responds with an even number of claps.)
- When someone claps three times, a pen is exchanged between the two people, always given with the left hand and taken by the right.

And so on....

After everyone in the group understands the rules governing their behavior, and perhaps have had a chance to practice for a few minutes away from the other half of the class, the two groups are brought together, with the newly-discovered species in the center of the classroom and the group of naturalists observing them from the edge of the room. The animal species behave as their rules determine, moving about and socializing; the naturalists try to decipher their elaborate rules. When a naturalist thinks he or she understands the species, he or she steps into the group and tries to become accepted by them; if he or she breaks a rule, he or she must be immediately rejected by the group (as a Philippine Eagle would reject a human who displayed incorrect behavior.) Make sure the animals know exactly how they as a group act when they are rejecting a clumsy naturalist. After a while, the roles are reversed and the naturalists become the animals.

After the exercise is over, spend some time drawing connections between the reading and the role-playing game, and discussing what was difficult or easy about the exercise.

Chapter Eight: "The Breeding Season: What Triggers the Clock?"

The fluctuating environmental factor in the tropics is **rainfall**.

Related Information:

• Having a breeding season is an environmental adaptation. The breeding season has to be timed so that when the young bird is first on its own, the availability of food is optimum; therefore, some species lay eggs when conditions at that time don't seem to be optimum. Some large temperate birds may even incubate their eggs when there is still deep snow on the ground. Many birds, therefore, need to have a sophisticated means of reading environmental clues which forewarn them and trigger reproduction before the optimum conditions exist.

• It is not clear yet if the breeding trigger is the sight of the rainfall itself, or the sound of it falling in the trees, or if the trigger is changes associated with the rain, such as greener vegetation or an improved food supply.

• Biologists who study raptors believe that, although both male and female are sensitive, the male is more sensitive to environmental signals which inform him that the breeding season should begin. It is then the male initiating courtship, through vocalizing, nest-building, and food transfer, which helps to trigger breeding behavior in the female. (Scientists at the Philippine Eagle Breeding Center have discovered, however, that initiating breeding behavior is not enough to trigger breeding responses in the female eagle if the season is incorrect, suggesting that the female does rely on some environmental clues.)

Short-Term Follow-Up Activity:

After rainfall has been established as the tropical birds' breeding season trigger, ask the class what the possible repercussions of changes in the environment (e.g., climate, changes in temperature and amount of rain,) might be on the breeding behavior of Philippine eagles, other birds, and other animals.

Long-Term Follow-Up Activity:

Have the students find—but do not disturb!—active birds' nests near the school or their homes. The students should sketch the nest and its occupants; determine the species; and record the activity and behavior of the birds. When are the eggs laid? When do they hatch? What food do the parents bring to the offspring? In order to make connections between environmental signals and breeding behavior, students should also record daily temperature, rainfall, and sunrise/sunset information (either directly or from newspaper or government office accounts.) Ideally, this project could continue with different classes over a period of years so data and observations could be compared over time.

Chapter Nine: "What's the Dirt on Siltation?"

This chapter consists of two sections. The first section presents factors contributing to the disaster in Ormoc in 1991. Students need to understand and explain the significance of the various factors, and how they worked together to create the tragedy. The second section consists of an experiment demonstrating on a small scale the kind of swift erosion which takes place when vegetation cover is destroyed.

Section One: Ormoc

What happened: On November 5th, the heavy rainfall fell on the upper slopes of the mountain range. Largely deforested, the land in this area was degraded and heavily eroded. Because the soils were so thin, much of the water washed away immediately rather than becoming absorbed by the soil; as the soil on the upper slopes was composed largely of clay, this also limited the amount of water which it could absorb. Significantly, no landslides were found in areas which still retained a cover of primary forest. The steep slope of the mountain range created naturally swift-flowing rivers; as a result, these rivers were narrow rather than wide. This is significant because when the excess water flowed into the rivers, carrying with it huge amounts of eroded soil and rocks, the narrow rivers could not transport the water fast enough, and the rivers overflowed. The Anilao River, for example, widened from 30m to 50m—within minutes.

The result was that a great deal of water and eroded material rushed down into the valley where Ormoc is located. Bridges were clogged with material, the thick muddy water quickly overflowed and in just a few minutes inundated the settlements of people along the banks of the rivers.

Section Two: Erosion Demonstration*

Setting up the trays is explained in the student workbook; a test-run a few weeks beforehand is recommended, but if you may want to do the experiment "cold" and involve the students in decisions about setting it up, such as the slope of the trays, the kinds of soil and plants to be used, and the speed and volume of the dripping water.

The questions at the end of the section move the students away from the sudden and dramatic but relatively rare experience of the flash-flood in Ormoc to the more subtle changes which are ongoing throughout the Philippines.

* Special thanks to Albert Atkinson for this lesson.

Chapter Ten: "Watersheds"

This unit focuses on map reading skills and builds upon the Chapter 9 lessons on siltation and the disaster in Ormoc. It requires students to use logical thinking to determine the three-dimensional shape of the land based on information presented in two-dimensional maps, and to make decisions about human settlement based on the information in a map. If your students are unfamiliar with topographical maps, there is a supplemental lesson below to introduce these useful maps.

In the first map, they should be able to infer that the approximate center of the map is the area of highest elevation—all the rivers are running away from the center, flowing outward in all directions. To make this inference, they need to understand, of course, that rivers flow in one direction and that they eventually flow into a lake or the sea. If they draw arrows in the wrong direction, this means the rivers flow to a certain point and then simply stop. (Reminder: Ask students to mark arrowheads in light pencil only so the workbooks can be used by other students in the future.)

If the map can be approximated on the chalkboard, individual students can be asked to come to the board and put arrowheads on different rivers, after all students have attempted the job on their own first. If there is disagreement, you should ask the students with differing opinions to explain their reasoning. After all the arrowheads are on the map, have the students turn to the next page. The topographical map on the next page should confirm the students' deductions about the shape of the land. If there are any errors on the board, they should be corrected and the corrections explained by using the topographical map. (If students have not yet learned about topographical maps, see the accompanying assignment below.)

Notice that the lines of elevation on the topographical map sometimes "bend" in a V-shape **towards** the rivers. Ask each student to write down why this might by so. Also ask how this piece of information (the V-shape pointing upstream) might be useful to someone who is reading a topographical map. (Answers: Rivers often cut into the slope, therefore lowering the elevation. You can demonstrate this by asking students to put their hands palm-down on their desks with their fingers slightly spread, and to picture rivers flowing from the backs of their hands and down the V-shaped channels between their fingers. This information might be useful to someone who needs to quickly determine either the direction of the slope of the land or the direction of the river's flow (especially if the map they are reading does not show either the mouth or head of the river (i.e., shows only a middle section of the river.)

Short Question Answers:

F is the fastest stream because it cuts across many contour lines in a short distance—it is dropping steeply from a height. The water flowing out of **C** would be faster because it has more rivers, coming down from the mountain, flowing into it. The cleanest drinking water would probably come from point **H** because the farther down the slope, the more likely the river will be contaminated by people (sewage or pesticides from their farms, for example.) If

the forest were clear-cut, **all** the rivers would be effected by siltation. The safest place to build would probably be **K** because it is at a higher elevation than **I** and is not located alongside a river, as **C** is.

Supplementary Lesson: How to Read Topographical Maps

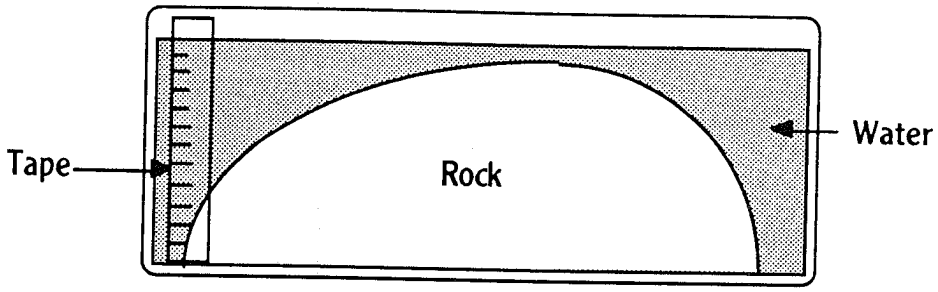
Topographical maps can be somewhat confusing at first. If your students are not familiar with them, here is an activity which will help them to visualize how elevation information can be represented on a flat map. It involves each student in creating a miniature topographical map of a rock.

Materials:
Rocks (approximately the size of a fist or two fists together)
Water and pourers
Clear or opaque plastic containers with straight sides (not bowls), deep enough to hold the rocks completely
Clear plastic wrap (or bags, cut open) (can be recycled from the garbage or lunch)
Pens or markers which will write on the plastic wrap
Rubber bands
Masking or clear tape
Rulers
Tracing paper
Graph paper

Procedure:
On the day before, pair up the students. As a homework assignment, ask each team to bring in a rock which has the approximate shape of a mountain, and (if not available at the school) a container and some plastic wrap. The rock should fit completely inside the container.

On the day of the lesson, have the students:
1. Cut off a piece of tape a little bit longer than the height of the rock, and starting with zero, mark off centimeters on the tape in steps of one centimeter.
2. Stick the tape to the outside of the plastic box with zero at the bottom of the box. (See the diagram below.)
3. Put the rock inside the box, arranged so it looks somewhat like a mountain.
4. Put the plastic wrap on top of the box and seal it tightly with tape or rubber bands.
5. Poke a hole in one corner of the wrap and carefully, without getting the plastic wet, pour water into the box until it reaches the one centimeter mark on the tape.
6. Look down onto the rock and trace onto the plastic wrap the line which the water makes around the edge of the rock.
7. Pour water up to the two centimeter mark and trace the new line which the water makes around the rock.

8. Repeat these steps until the point when adding one more centimeter of water will cover the rock completely. Take your ruler and, from the side, measure the last remaining piece of rock. This is the highest point or "bench mark" of your rock-mountain.
9. Take a piece of thin paper and trace the lines from the plastic sheet. Mark each contour line with its correct elevation; don't forget to include the bench mark. You now have a topographical map of your rock.



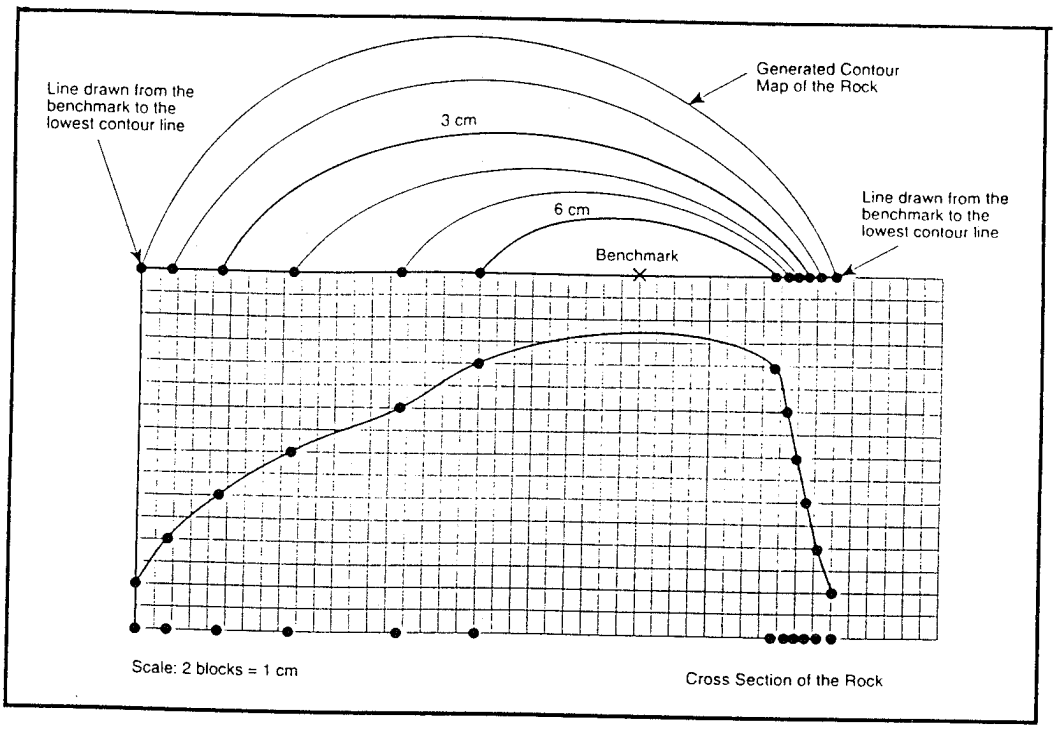
Side View

To Make a Cross-Section of the Rock:

As an added step which will help the students see how contour lines can be used to give information about the shape of the land, they can be shown how to make a cross-section of their rocks using the topographical maps they have just created.

Procedure: Have the students:

1. Draw a straight line across the topo map, passing through the bench mark.
2. Decide on a scale, based on the number of squares on the graph paper. (For example, two blocks on the graph paper represents one centimeter elevation for the rock.)
3. Tape the graph paper along the line marked on the map. Where the first contour line meets the line drawn through the bench mark, draw a vertical line, on the graph paper, from that point to a base line at the bottom of the graph paper. (See diagram below.)
4. Count up from the base line the number of boxes needed to represent the first line of elevation (based on the scale you decided upon,) and mark this point.
5. Wherever a contour line meets the straight line, make a mark on the base line on the graph paper and count up the proper number of boxes to represent that elevation.
6. Connect all the dots. You should now have a picture of what the rock would look like if you sliced it open through its highest point.



Chapter Eleven: "Ecosystems Out of Balance: the Golden Apple Snail"

Subjective grading for this assignment is inevitable, but explain from the beginning that you're looking for relatively complex food chains, good-quality observation notes which show that time was spent observing the chain in action, and finally a story which shows thought and creativity.

Making Connections: People, the Eagle, the Forest

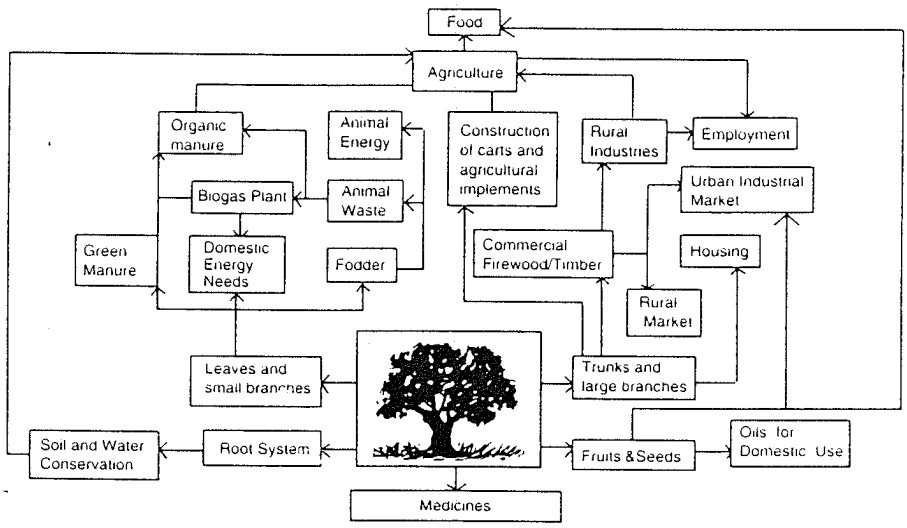
The purpose of this final exercise (which is not in the students' workbook,) is to draw together many of the concepts and themes which have been emphasized throughout the lessons in the book, and to reinforce this reality: The future of the people of the Philippines is unavoidably linked to the future of environment of the Philippines. The exercise is in the form of a game which calls upon not only the memories of the students, but also their ability to make connections.

Chapter Twelve: "What Price a Tree?"

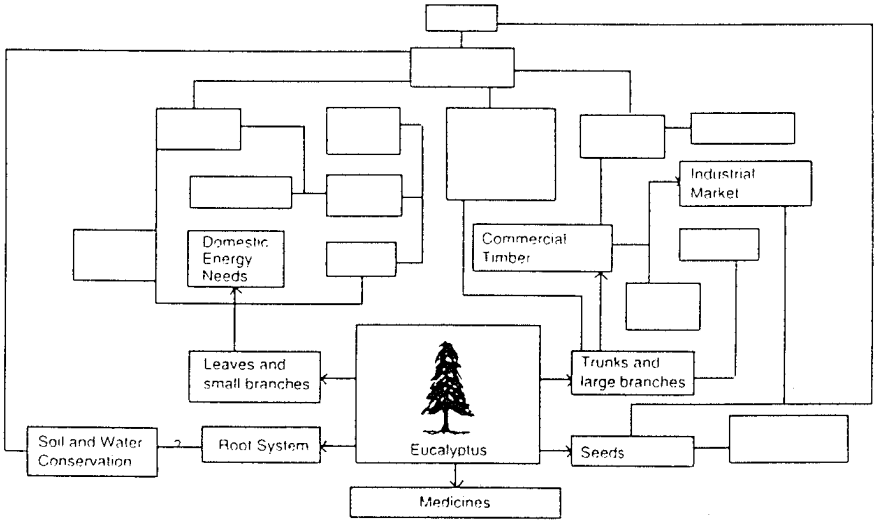
Two objectives of this lesson are to demonstrate that:
(a) One can assign value to a resource by calculating the monetary value of its outputs; **but**
(b) Such calculations leave out an infinite number of uncounted benefits of keeping the resource—or the costs of using it up.

The Indian writer/activist Vandana Shiva has pointed out that the value of a tree goes beyond its market value; her view can be summed up in the following figures (which you may want to draw on the board after the students have finished their activity):

The Contribution of Traditional Tree Species to the Rural Life-support Systems.



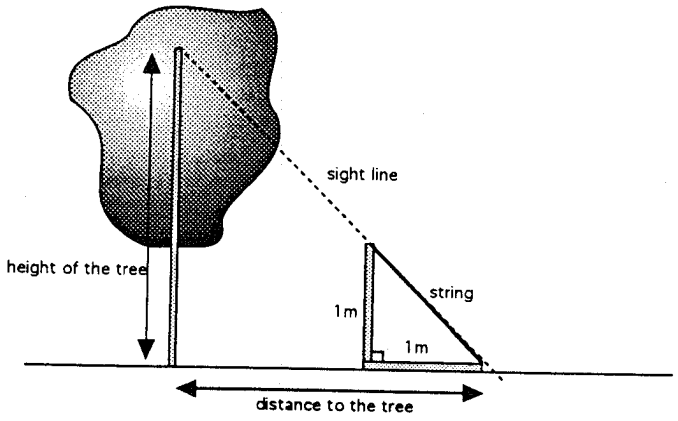
The Comparative Contribution of Eucalyptus to the Rural Life-support Systems



Integrating Math with the Lesson: Calculating Volume of Lumber in a Tree

• The local price of lumber needs to be calculated for **volume** (eg., pesos per cubic inch or pesos per cubic centimeter.) The volume of a plank of wood is height x width x length. The trunk of a tree is approximately the shape of a cylinder; the formula for the **volume of a cylinder** is: $V = \pi r^2 h$. The **radius** can be determined by measuring the circumference of the trunk and using the formula: $r = C/2\pi$.

• The **height** of a tree can be estimated by using a right triangle, as in the diagram below. Construct a right triangle using two 1m pieces of wood and a piece of string. Align the level triangle so that its hypotenuse (the string) forms a line to the approximate point where the trunk of the tree ends. (This may be difficult with some tree species.) The distance from the tree to the end of the horizontal meter stick will be the same as the height of the trunk.



☛ For an added challenge, give the students meter sticks and string and a table of formulae (some irrelevant to the exercise) and ask them to devise a way to measure the volume of a tree's trunk—without climbing it.

The group activity encourages teamwork and rewards creative thinking:

1) Divide the class into groups of no more than four students, if possible. One student in each group is a note-taker. Give the groups three minutes to answer the question of what is left out of the calculation of value in the previous activity.
2) After the time is up, the note-taker of each group takes turns reading out their list. All answers should be quickly listed on the board as they are read out. If any other group has the same answer written down, they say "Got it," and that answer is crossed off all lists; since it is not unique, no one gets a point for it.
3) Any answers which are unique to the group earn a point. Answers might include things like "Shade on a hot day," "The sound of the leaves in the wind," and "Medicines." If a note-taker reads out an answer which has already been read out loud, their team loses a point (to encourage close listening and to save time.) Although it might seem like the process of reading lists will take a long time, as answers common to different groups are crossed off, the time required to read answers aloud should decrease.
4) At the end, the group with the most number of unique answers wins, and the board should be full of valuable characteristics of a tree which are not included in most calculations of what a tree is worth. Divide up the answers on the board evenly among the groups and have them discuss for a few minutes a **peso** amount for each characteristic they have been given. (E.g., how much do they think "shade" is worth in pesos?) Use the difficulty they will probably have in doing this to focus discussion on why it is so hard to use just one standard to calculate something's value.

Chapter Thirteen: "Indigenous Filipino Views of the Land"

The following lessons are designed to engage students actively in an investigation of the issue of resources and how we manage them. In the first activity, the students are given a resource to manage–though, as explained below, they don't realize that this is what they are doing. The second activity, a short reading about the history of pre-Hispanic traditional views of ownership and resource management in the Philippines, should take place perhaps a week later. As a final activity, you might have students interview older people and report orally to the class about what they remember of past practices of land ownership and resource management.

Activity: "Take as Many as You Want"

This activity can be done perhaps a week before you would like to conduct the actual discussion about ownership and resource management. Once the ground rules are laid out and the container of candies is set up, you can resume lessons on some other subject.

It is better not to overly discuss what is happening in this activity, but rather to simply allow things to happen. You can not predict what exactly will happen in this activity, and should not feel that the lesson "did not work" if the students don't behave in a particular way. Whatever happens should become the focus of a discussion involving all the students, a discussion in which ideas about what could have happened differently are discussed openly. You may want to try the experiment a second time, after such a discussion, and see if there are any changes in behavior. One issue which is likely to come up is the notion of human nature, and you should be prepared for comments such as "But isn't it human nature to be greedy?" The activity can open up into a discussion of, for instance, cases where humans are not greedy, cases where they are, and what kinds of circumstances create what we call "human nature."

Materials:

- Some large container which can be left in a freely-accessible corner of the classroom or school.
- A bag of small candies (perhaps 100 pieces per 40 students)

Procedure: Count the candies before putting them into the jar, but don't tell the students. If they choose to begin by counting the candies and figuring out each student's equal share, this is up to them; it should not be suggested by the teacher. (Later, during discussion you might ask questions about why this step was or was not taken, and how that might have effected what subsequently happened.)

Explain that anyone in the class can take as many candies from the jar as they would like. And, at the end of each day (week? every other day?), you will replenish the candies. However, you will replenish them according to the scale below, (which you should leave posted for all to see during the activity.)

At the end of the first day/week, you will count the candies remaining in the jar and add to them at the following rate, based on an initial count of 100:

If this many candies are left:	**You will add candies at this ratio (candies left: candies added):**
0 to 20	1: 0.5
21 to 60	1: 1
61 to 80	1: 2
81 to 100	1: 3

Possible Outcomes:

a. The students might divide up the candies, give them out equally, and eat them all immediately.
b. They might count the candies, agree to give out a certain proportion to each student, and might all agree to leave a certain number of candies in the jar to be replenished, which might work exactly as planned.
c. They may follow what happens in (b), but one or more students might dip into the jar to take extra candies when others aren't looking.

Discussion:

Discussion about the candy jar activity should take place perhaps a week after it was begun, to allow enough time for the experiment to unfold. Explain that the jar of candies represents renewable resources (trees, water, soil, animals, etc.,) but ones which are not infinite or inexhaustible. Once you've made the connection to use of natural/renewable resources, have a discussion about this analogy: How was the example of the candies **similar to** the situation of using resources? How is it **different from** the situation? Possible answers might include things such as:

Different because: no police or government in classroom, so we could make up our own rules; we weren't relying on these "resources" (candies) for our lives; there was a teacher there to magically replenish the resources; and (maybe most importantly) we were able to know exactly how much resources were available to us, and we knew exactly how much we could use without destroying the system.

Similar because: you can't expect resources to last forever or to be always renewable; you need to maintain a lot (e.g., a certain amount of tree cover in a forest) in order to maintain the resource.

C. Introduction to Reading:

Initiate a discussion about "ownership" by using objects in the classroom. For example, you might ask a series of questions such as: "Who owns this pen? This door? This school? This basketball? This air? This sunlight? Are there any things that it's hard to say definitively who owns them? What does "owning" mean—in other words, what actions can you take with something you own? Can you burst your own basketball, even if other people want to play with it? Can you throw your own basketball through a shop-keeper's window? Through the classroom window? Explore some of the notions that go along with our unquestioned notions of ownership and use.

You may want to stimulate discussion by using this quote, from a Kalinga elder:

> "Such arrogance to speak of owning the land, when **you** shall be owned by **it**. How can you own that which will outlive you? Only the race owns the land because only the race lives forever."

Then have the students read the handout **The Idea of "Ownership" in Traditional Filipino Society** in the student workbook.

Chapter Fourteen: "Biodiversity vs Uniformity"

The idea of this lesson is to have students survey various locations to approximately determine the extent to which biodiversity, measured by the number of species per square meter, has thrived or dwindled.

Before beginning the activity, first have students read **Background Reading on Biodiversity** in the student workbook.

Activity:

The class should be broken up into teams of four or five.

Teams construct wooden frames measuring one meter by one meter. These will form standardized areas with which different habitats can be compared.

Teams hypothesize: Among the sites chosen for the survey, where would you expect to find the greatest biodiversity? Why?

Teams take their frames to various locations–forest, pastureland, fruit orchard, etc.–and spread out, laying their frames on the ground. The team members count all plant, animal, and insect species which they find. (In other words, ten ants count as one species, but two different spiders count as two different species.) Team members should carefully record their results.

Data collected over the course of many surveys, carried out in various locations, should be used by students to make conclusions about the extent of biodiversity. Where were the greatest concentrations of species found? Were there differences in, for example, the diversity of plant vs insect species? Did teams surveying different spots within the same location have consistent results? If not, suggest reasons for discrepancies. For areas where there is not a great variety of species, have students suggest what might be done to reverse the trend.

Chapter Fifteen: "Population & Deforestation"

Have the students take an initial position on how important they think "overpopulation" is in the deforestation of the world's (and the Philippines') forests. You might ask them to "vote" for their position by walking to different corners of the room, one corner for "It's the main problem;" another for "It's a big part of the problem;" another for "It's a small part of the problem;" and another for "It's not a part of the problem."

The questions in this lesson are designed to call into doubt the automatic connection which is often made between a high population and a high incidence of deforestation. In each question, the correct answer is the answer which goes against what might be expected.

Q1. Country B, the less densely populated country, has maintained just 2% of its forest cover.

Q2. Region C, with half the population, has cut more forest than Country D.

Q3. All three countries have the same annual rate of deforestation: 3,600 sq km.

Q4. Country H uses much more paper; Country I would have to increase its population to 34 **billion** people to use the same amount of paper as Country H's 250 million people.

The countries described in the questions are:

(A) Japan
(B) Cuba
(C) Central America
(D) France
(E) Vietnam
(F) Peru
(G) Papua New Guinea
(H) USA
(I) India

Discussion:
The information contained in the questions in this lesson should suggest to the class that there is no simple correlation between population and deforestation. A former head of forestry at the United Nations' Food and Agriculture Organization has written that:

"There is no simple relationship between the extent of the forests and the size and distribution of the human population. Instances can be found in which large numbers of people live in harmony with their forests, and others where forests are devastated although few people are present."

The often-used example of the Amazon rainforests can be used to illustrate this point. The Amazon makes up over 60% of Brazil's area, but less than 10% of Brazil's people live there. Only two to three million people actually live in the Amazon forests; were they responsible for the destruction of half a million square kilometers of forest between 1975 and 1988? Neighbors Malaysia and Indonesia both have tropical forests. Indonesia has more than ten times the population of Malaysia, but Malaysia has cut almost 40% of the forests which Indonesia has cut. Clearly, as the FAO head wrote, "It is not so much the number of human beings that has the crucial impact as the way in which human society is organized." One of the ways in which human society is "organized" is in the consumption of its people; the figure for the consumption of paper in the US as opposed to India is an indication of the fact that although there may be many more people in India, they consume much fewer resources per person than people in the US. If this is the case, what does it mean then that India is "overpopulated"?

After the discussion, you may want to ask the students to re-vote by moving to different parts of the classroom again. Are there significant shifts in the positions now taken by the students?

Chapter Sixteen: Making Connections: People, the Eagle, the Forest

The purpose of this final exercise (which is **not in the students' workbook**,) is to draw together many of the concepts and themes which have been emphasized throughout the lessons in the book, and to reinforce this reality: The future of the people of the Philippines is unavoidably linked to the future of environment of the Philippines. The exercise is in the form of a game which calls upon not only the memories of the students, but also their ability to make connections.

Making Connections Concentration Game
Write each of the following phrases in large print on separate pieces of paper. Some of the phrases may be duplicated (e.g., five "The Philippine Eagle" pieces,) but there should be an even total number of pieces of paper.

Drought

The Price of Fish

The Forest

The Philippine Eagle

Soil Erosion

The City

Flooding

Fisherfolk

The Coral Reef

The Price of Rice

Population

Poverty

Farmland

Money

Logging

The River

Forest Roads

Create a grid on the blackboard or corkboard, using numbers along one axis and letters along the other (to make selecting the squares easier.) There should be enough boxes on the board to hold all of the pieces of paper. Attach the pieces of paper face down on the board, with the blank sides facing the class.

Divide the class into two teams. A student from the first team begins by calling out the first card to be turned over (for example, "D5") and then the second (for example, "A2.") Within a certain amount of time (e.g., to the count of five,) the student has to draw a connection between the two phrases turned over. If the student makes a connection, his or her team earns a point and the two cards are taken off the board. If they fail, the cards are returned face down to the board and a student from the other team chooses the next two cards to turn over. They can choose the previously chosen cards if they like. A large number

of cards on the board at the beginning makes for a more challenging game. When all the cards are gone, the game is over.

Some sample answers:
If the student chooses "Drought" and "Flooding" they might say: "Cutting down trees can lead to both droughts and flooding because having trees around keeps the climate wetter during the dry season, and stops run-off and silt buildups which cause flooding in the wet season." If the student chooses "Coral Reefs" and "Forest Roads" they might say: "Coral reefs are killed when roads are cut through the forest because the roads help create erosion and silt which fill the rivers and choke off the coral when it reaches the sea." If the student chooses "Poverty" and "The City" they might say: "If people can't make a good living in the countryside, they have to move to the city to try to find work."

The Philippine Eagle Workbook

lessons on the interrelationship of the eagle, the environment, and people for the Philippine classroom

DRAFT

The Phillipine Eagle Workbook

lessons on the interrelationship of the eagle, the environment, and people for the Philippine classroom

by Ken Byrne

With the assistance, guidance, and support of the Philippine Eagle Foundation, Inc., and the Ecological Society of the Philippines.

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1. Oral History: Environmental Changes in Your Community

Have your parents or lolo or lola or older relatives or neighbors ever told you about what life was like when they were young? Did any of their stories ever mention the natural world—the trees, the animals, the weather? Were you interested in their stories, or listen with just one ear, and forget what they said as soon as they had said it? If you have children, will you be telling them about the forest you saw when you were young, that no longer exists for them to see?

This lesson requires you to become an oral historian, a recorder of a world which, for better or worse, no longer exists. The kind of knowledge which you will uncover, record, and teach to others is not the kind of knowledge which usually appears in school textbooks. (Do you think that make it less "real" or "true"?)

You may be the only person who can capture the experiences of an older generation! Without you, their knowledge and experiences might be lost forever!

How to Conduct the Interview:

❑ Start by explaining the **purpose of the project**.

❑ During the interview, your goal is to help the person to talk about the past. When interviewing, don't be satisfied with a short answer. For example, if you ask "Have there been many changes in the environment since you were little?" and your lola says "Yes, of course," then ask further questions. Perhaps you can ask about what animals or birds she saw when she was little. Or ask her what she misses the most about the natural environment from her childhood—games they played, food they ate, special places they visited, and so on. Perhaps ask her what she would most like to show you from her childhood, if she could. Remember that "the environment" can include things like

climate (rainfall, temperature,) and the availability of resources.

❑ Tape-recording the interview is ideal, but **taking notes** can be almost as effective. Take short notes of key words while the person is talking, but don't worry about writing down every word. As soon as the interview is finished, read over your notes and try to make them as complete as possible, using complete sentences and adding any details you may have missed when taking notes. If possible, show this second draft to the person and ask them if they want to add or correct anything.

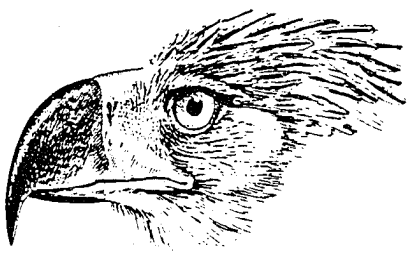
❑ Don't forget to record some **basic biographical information** about the person who you interview:

Where did they grow up?
How old are they now?
What is/was their profession?

After the Interview:

To help you think about what you have learned about environmental changes, answer these questions:

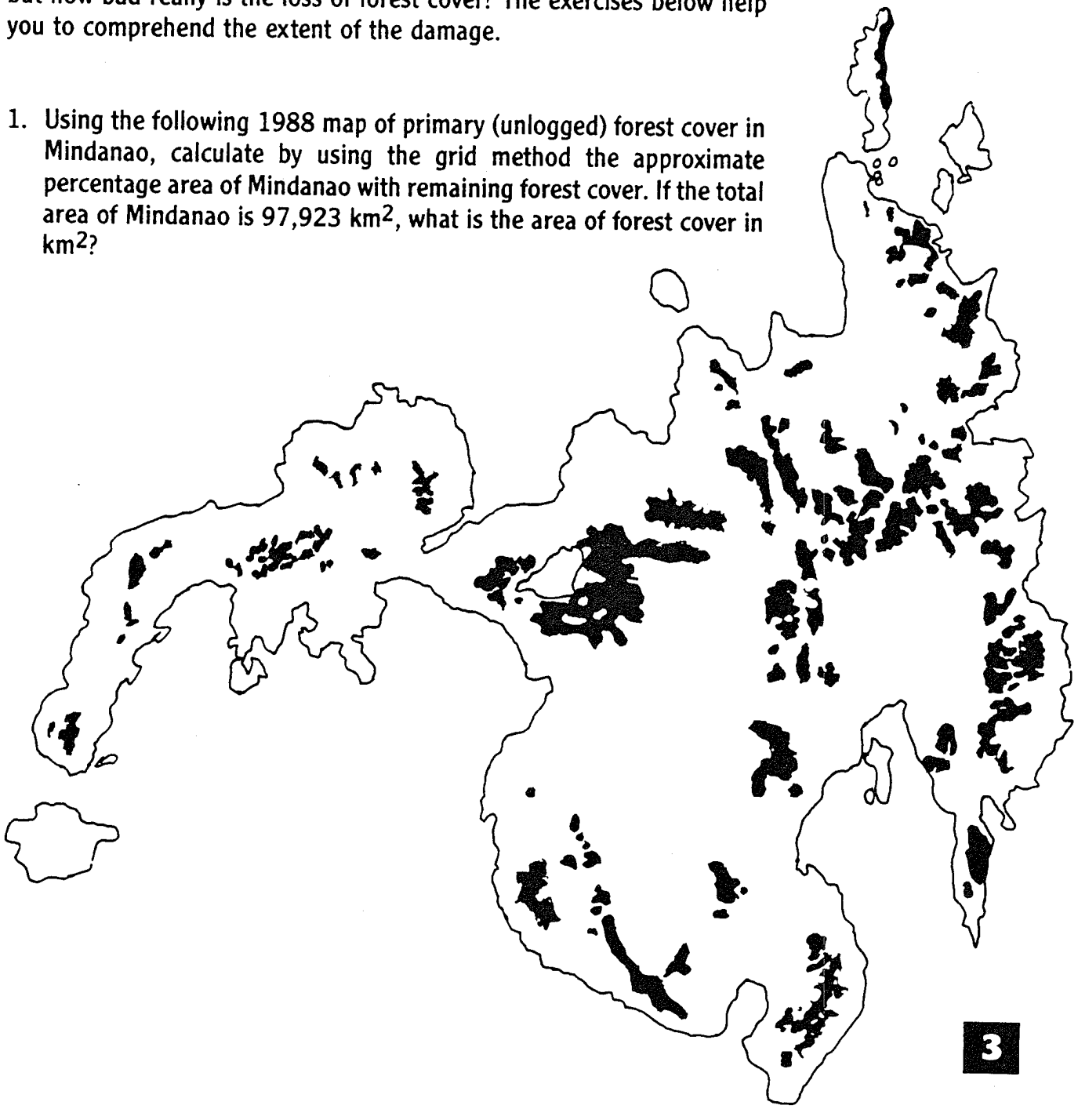
1. In your opinion, have the changes in the environment been mostly good or mostly bad? Why?
2. If you could go back in time, say forty or fifty years, what would you most like to do or see, based on your interview?



2. Our Forests: Deforestation in the Philippines

You may have heard about the problem of deforestation in the Philippines, but how bad really is the loss of forest cover? The exercises below help you to comprehend the extent of the damage.

1. Using the following 1988 map of primary (unlogged) forest cover in Mindanao, calculate by using the grid method the approximate percentage area of Mindanao with remaining forest cover. If the total area of Mindanao is 97,923 km^2, what is the area of forest cover in km^2?

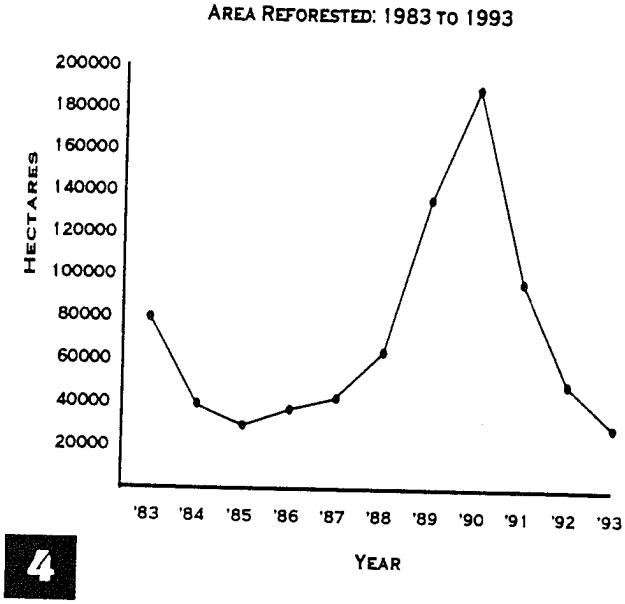


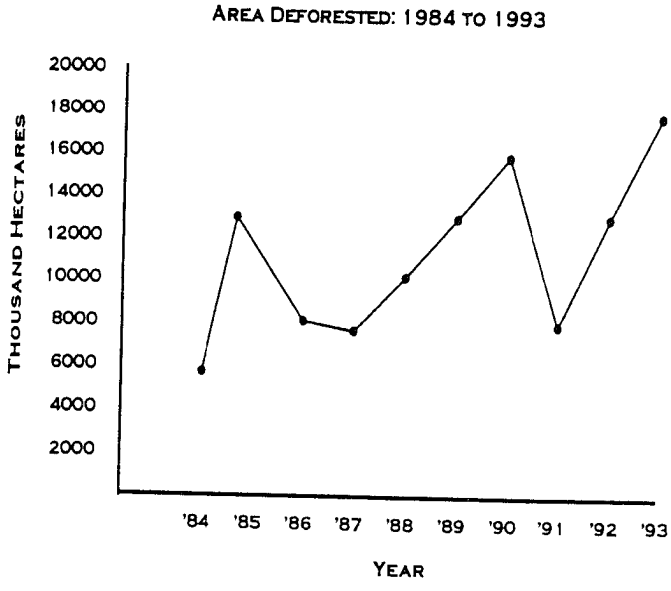
2. The following data is on forest cover in the Philippines from 1934 to 1993. Covert the data into graph form (e.g., pie chart, bar graph, or line graph.) Decorate the graph appropriately. Then, in a paragraph under the graph, predict the year when no old growth forest will be left in the Philippines. Include in your paragraph possible reasons why your prediction may not be accurate (in other words, why the actual date may be earlier, later, or postponed indefinitely.)

Forest Cover in the Philippines
(Total area of the Philippines is approximately 30,000,000 ha.)

Year	Old Growth Forest	Degraded Forest	Total Forest
1934	11,000,000 ha	6,000,000 ha	17,000,000 ha
1969	4,700,000 ha	5,800,000 ha	10,500,000 ha
1993	900,000 ha	3,000,000 ha	5,700,000 ha

3. (a) The following graphs were taken from a statistical yearbook of the Philippines for the year 1994. Study them very carefully. Why do the graphs, when placed side-by-side, present a misleading picture of the problem of deforestation and the rate of reforestation in the Philippines?





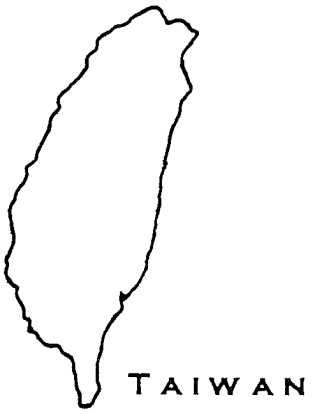
(b) Convert both graphs into a single, less misleading graph.

(c) Calculate how many hectares of land would need to be replanted just to counteract the amount deforested in 1993 alone; how many to restore Philippine forests to 1969 levels. Based on a spread of one meter between seedlings, how many seedlings would be contained in one hectare? From this information, how many actual trees would need to be planted (and maintained!) to restore forests to 1969 levels?

4. If more time and research materials are available:
Create a reforestation project proposal, based on either a real or imagined location. Teams of students should work together to create a plan for reforesting a denuded area.

Make sure the following are considered:
What tree species will be planted? Which ones will be planted first?
Which slope will be wetter? Drier? How will this effect your plan?
How many seedlings will be needed? How much will they cost?
What are the major threats to young seedlings?
How will young seedlings be protected until maturity?
What are the major threats to mature trees?
How will mature trees be protected?
When will trees become mature?
How will the mature forest be managed?
Will people in the area be allowed to use the forest's resources?
Will people be displaced from the area because of the forest?
If people are displaced, what will they do?
What is the role (if any) of the government, volunteers, and NGO's in the project?
What mammals, birds, insects, and reptiles would you like to attract to your forest? How can you attract them?
Who will "own" the forest?

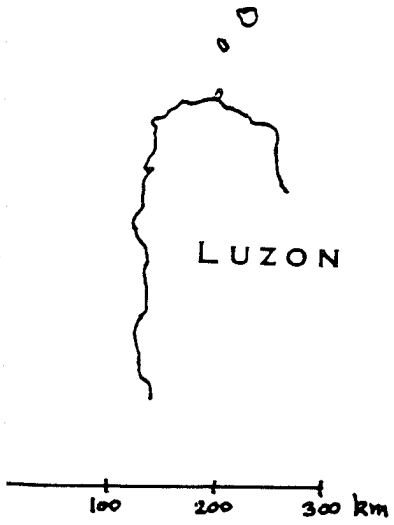
(Possible sources for information include the DENR, PAWB, Forest Management Bureau, Institute for Rural Reconstruction, local universities, and environmental NGO's.)



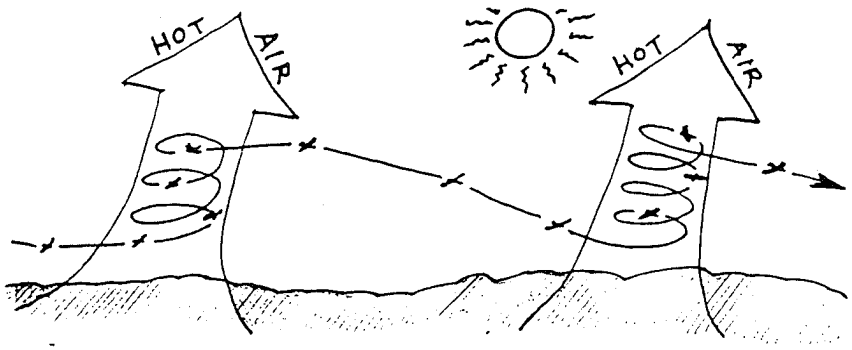
3. The Mystery of Mr. Tsai: The Flight of the Philippine Eagle

One of the Philippine Eagles in the Malagos Breeding Center of the Philippine Eagle Foundation was donated by a Chinese bird collector in Taiwan. Since the Philippine Eagle had been found only in the Philippine islands of Mindanao, Luzon, Samar, and Leyte, many wondered: How did this eagle (named "Mr. Tsai" after its donor,) end up in Taiwan? Could it have flown across the sea?

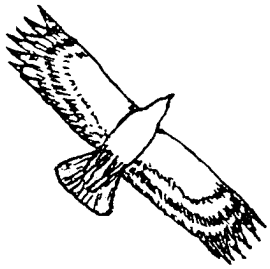
To determine the answer, you will need to understand a few points about how the Philippine Eagle flies. Put together all of the information below and then decide in your own opinion how Mr. Tsai arrived in Taiwan.



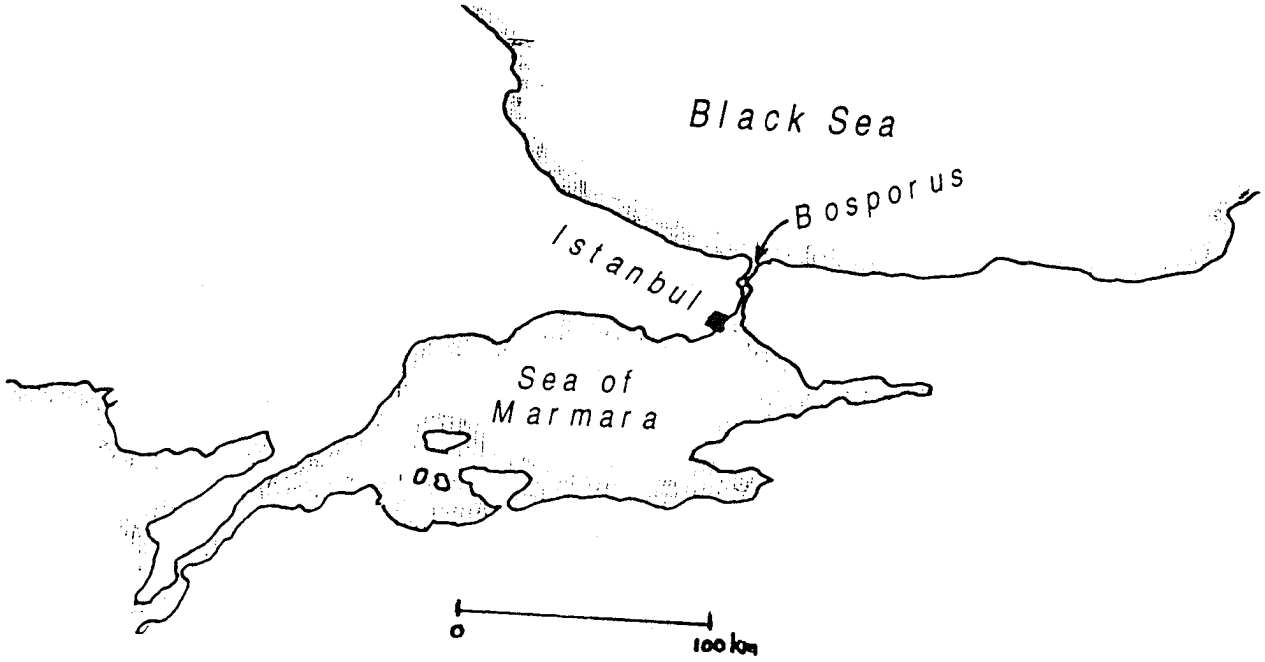
☞ When soaring, the Philippine Eagle doesn't flap its wings. (When birds flap their wings, they use up about 15 times as much energy as when they are still.) It conserves energy by using natural columns of hot air called "thermals." These thermals occur after the midday sun heats up the ground. Some parts of the ground heat up faster and become hotter than others (for example, outcrops of bare rock.) Because hot air is lighter than cold air, the air above these parts rises quickly, acting as a kind of elevator of hot air. The eagle soars higher and higher in a circular motion, and then, after it reaches a certain height and the air begins to cool, it leaves the thermal and glides, losing altitude as it travels. When it reaches another thermal, it is again able to gain height by circling within the column of warm air. By travelling using thermals, eagles can travel tens of kilometers without using up energy by flapping their wings.



☞ The best time of day to observe a flying Philippine Eagle is in mid-day. At this time, the eagle leaves its nest, usually built in a large tree prominent on the lower slope of a mountain, and glides with its huge wings outspread and unmoving, like this ➳



☞ A Philippine Eagle is a bird of prey, or "raptor." Other raptors often travel very long distances, using thermals as the Philippine Eagle does. There are a number of unique places in the world where bird-watchers can see huge numbers of raptors flying in great movements. These are known as "concentration points" because they act like funnels to concentrate the travelling birds of prey over one narrow piece of land. One such concentration point is over the Bosporus, a very narrow channel of water near Istanbul, Turkey. Locate this point on the map below; why would so many birds come together to pass over this point?



☞ Do thermals form over water? Which heats up faster and hotter: land or water? Devise an experiment to determine which creates better thermals.

Now that you know a little more about the flying habits of the Philippine Eagle, read the following newspaper account about how Mr. Tsai arrived in Taiwan:

> "Mr. Tsai is back home at last.... Mr. Tsai was captured in Taiwan. He must have island-hopped from Luzon where the mountains are almost denuded and already inhospitable to his kind. He must have been searching for the kind of habitat he was used to—virgin mountain wilderness, untouched and unpolluted by man."
>
> (from Metro Manila Times, 2/29/1984)

Now decide: How do you think Mr. Tsai got to Taiwan? Write your answer on a separate piece of paper and be sure to explain your reasons fully. Be prepared to defend your opinion!

The Eyes of a Raptor (I)

If a human had an eye which was proportionately the same size of a raptor's eye, relative to the size of its head, the human's eye would be the size of a tennis ball.

It has been estimated that a Philippine Eagle can see about eight times better than a human. Do this simple illustration. Have a friend write a message, in letters 2 to 3 cm high, on a piece of paper and stick it on a wall. From a distance where you can't read the message, start walking towards it and mark the spot from which you can read the message. Measure the distance from this spot to the piece of paper and then multiply this by eight. Pace out the new distance from the paper and look again at the paper. If you were a Philippine Eagle, you could read the note from here!

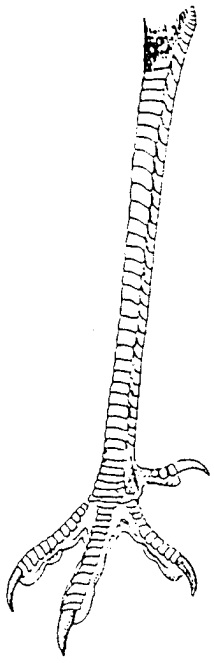
4. Evolutionary Adaptation: The Talons Tell Us

Anyone who handles birds of prey soon learns to keep a close eye on the powerful legs and talons (claws) of the birds; they are the tools used to inflict the real damage, not the hooked beak, which is designed more for tearing meat once it has already been killed. Raptors usually kill their prey by squeezing with their talons or from the force of the impact when then swoop down to seize the prey.

Different birds of prey, however, have evolved different forms of these dangerous weapons, depending on the prey which they hunt.

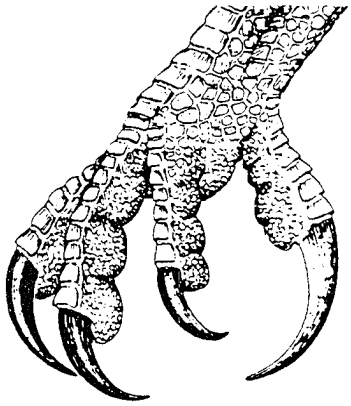
For example, the length of raptors' legs show a great variety:

If the prey is...	**Then the legs tend to be...**
• Other birds caught in the air	• Long & thin to improve its reach
• Mammals caught on the ground	• Short & strong to absorb the impact of the attack.



The size, thickness, and shape of a raptor's talons have also evolved to match its prey. Study the drawings of birds' talons below and match them to their owners, described on the next page.

(1)



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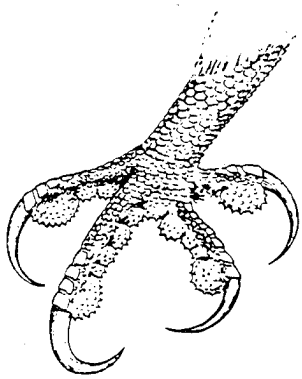

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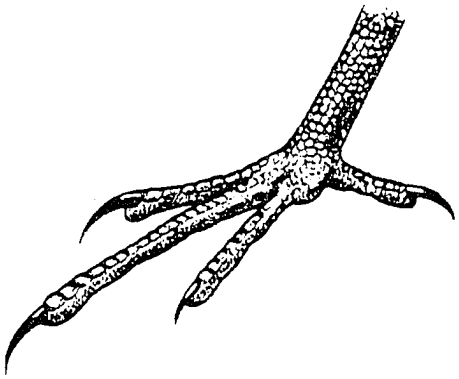


(4)

A. The Vulture spends a lot of time walking around on the ground, eating carrion (animals already dead when it arrives on the scene.)

B. The Sparrowhawk eats other birds, which it often catches in mid-air.

C. The Osprey eats fish—strong and slippery—which it snatches out of the water.

D. The Philippine Eagle eats mammals and snakes, which it needs to be able to kill quickly, often by snapping the spinal column.

5.The Relation Between the Sexes: Why Are Female Eagles Bigger?

In most birds, the male is larger than the female (think of the chickens and roosters that you've seen.) In birds of prey, however, this pattern is in most cases reversed and the female is bigger than the male. In the Philippine Eagle, the female is noticeably larger; in fact, one of the few ways of positively identifying the sex of a Philippine Eagle is to measure the length of their legs and their weight. The average weight of a female Philippine Eagle is in the 6-6.5 kg range, with some captive birds reaching 8 kg; the average weight for a male is in the 4.5-5 kg range, with the largest reaching 6 kg in captivity. During courtship, if the male is not very careful, making his intentions clear and reading the female's signals correctly every step of the way, he risks becoming the female's dinner. Indeed, two males were killed at the old Philippine Eagle breeding center in Baracatan by the females when their courtship proved unsuccessful.

So then: Why is the female Philippine Eagle bigger?

To work out your solution to a mystery which has puzzled many scientists over the years, you will need to think like a natural scientist: study the following information and apply your knowledge of natural selection to construct a feasible hypothesis about why female Philippine Eagles are considerably larger than their male mates.

❑ **Natural Selection and the female/male relationship:**

There is competition between different **species**, and also between **individuals** in the same species. For example, there may be competition between vultures and hyenas over the dead carcasses of animals on the African savannah; there may also be competition between the vultures themselves over who will get the largest share of the carcass. There can also be competition among individuals of one sex over who

will mate with the most desirable member of the opposite sex.

Charles Darwin theorized that when there is a difference in size or color between the sexes even though the activities and general life-style of the male and female are similar, then the difference is probably due to a competition between members of the same sex. This competition is over who will get the most desirable mate.

Question: What would "desirable" mean to a bird of prey?

Those who are more successful in this competition will be more likely to breed and to pass on their genes to the next generation, and the less successful will be less likely to breed. In this way, the difference in size develops through the generations.

❑ Dimorphism and Birds of Prey:

The difference in form (size, color, etc.) between the sexes is called "dimorphism," It comes from the Greek words "di-" meaning "two" and "morphos" meaning "form."

There are two parts to the problem:
- Why are female raptors usually larger than males of the same species?
- Why do some raptor species have higher degrees of dimorphism than other raptor species?

The two questions are probably linked. First to the second problem....

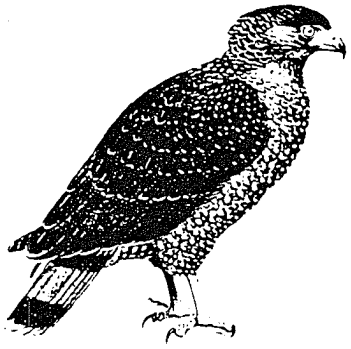
Not all species of raptor have a high degree of dimorphism. Understanding why some species have a great difference in male-female size and why others do not should therefore prove to be an important piece of the puzzle. Natural scientists discovered a relationship between dimorphism in raptors and their usual prey. The following chart lists raptors from no dimorphism to a high degree of dimorphism based on their usual prey:

Dimorphism:	Usual Prey:	Example:
No dimorphism	Carrion (dead meat)	Vultures
None to Slight	Snails	Snail Kite
Slight to Moderate	Insects	Philippine Falconet
Moderate	Reptiles	Philippine Serpent Eagle
Moderate to High	Mammals	Philippine Eagle
High	Fish	Philippine Sea Eagle
Highest	Birds	Peregrine Falcon

What can you say about the relationship between the **degree of dimorphism** and the **type of prey**? In other words, as dimorphism increases, what characteristic of the prey increases also?

❑ The Roles of the Male and Female Philippine Eagles:

Often during breeding and rearing of the young, it is the male raptor which provides food for the female and young fledgling. During the courtship rituals of the Philippine Eagle, the male offers food to the female as part of the process of convincing her that he is a good mate. (This is known as the "food transfer.") The female often offers some of the food back to the male in an exchange which helps to solidify the relationship. During the incubation of the egg and the rearing of the young eaglet, both the female and the male share parental duties, (such as building the nest or feeding the eaglet,) but the male spends more time hunting than the female does. (In some species of raptor (for example, the Galapagos Hawk,) the availability of food is so scarce that two males are needed to catch enough prey to feed the mother and the young!)



Philippine Serpent Eagle

During incubation, the female tends to spend much more time on the egg and relies upon the male to bring food through perhaps the fifth month after hatching; in other words the male is the chief provider of

food for the mother during incubation (which takes approximately two months,) and then for the mother and the eaglet for another five months.

During courtship, it is the male who initiates. He begins with vocalizations (sounds which are specific to initiating courtship.) If things progress properly, and he receives positive signals from the female, he starts picking up sticks and leafy twigs and fusses with them, signaling that he is ready to settle down and start nest-building. A third step in the process is the presentation of food, or the "food transfer," which is apparently a way of signaling to the female that the male suitor is a good provider.

Male-female pairs live with each other year-round, but although they spend time together each day and can be seen soaring together and bedding down in the same nest, they do not share food; such behavior is reserved for the breeding season.

❑ Here are some **Guiding Questions** to help you construct your hypotheses:

Which individuals survive in natural selection?
Why is there more dimorphism in some raptor species than in others?
What is the competition among female raptors?
What advantages might there be to dimorphism? For the larger females? For the smaller males? For the species as a whole?

Preening

If you watch a bird who is comfortable and relaxed, they will probably spend some time preening themselves—what looks like "combing" their feathers with their beaks. Why do they do this?

Feathers are made from a protein called keratin, just like claws, horns—and your own hair! They are incredibly flexible and strong for their light weight, and they are also beautifully engineered. Study a feather carefully. Play with its barbs. Try to imitate with your fingers the action of a bird preening. Study the feather before and after this "preening." Draw before and after pictures of what you see under magnification. Beneath the drawings, explain why you think birds spend so much time preening.

6. Philippine Eagle Egg Mystery

(Or: You'll Never Look At Your Scrambled Eggs In the Same Way Again)

The Philippine Eagle's egg loses 15% of its weight from the time it is laid to the time it is hatched. Why? The answer has a lot to do with respiration and the exchange of gases.

The key to the weight loss is the presence of tiny pores (holes) all over the surface of the egg. When first laid, the egg is the same temperature as the mother's body, but as it cools, the contents of the egg shrinks slightly (more than the shell itself.) This causes a vacuum to form which sucks in air through the tiny pores. This air collects at the broad end of the egg, forming an initial, small air sac.

As the embryo develops, it starts to produce water as one of the byproducts of using the nutrients inside the egg. This water adds to the general supply of moisture inside the egg. Part of the water supply slowly evaporates through the pores of the shell. If the water loss is too low, there will not be enough air in the air sac, which the developing eaglet will need for breathing in the later stages of incubation. If the water loss is too high, though, the embryo will dry out; if too dry it can die or become stuck in its membrane when hatching.

Therefore, the pores in the shell allow for evaporation of water so the air sac can form properly—and this is what causes the 15% drop in weight over the course of incubation.

Related Eggstremely Interesting Information

The Egg "Breathes"

Like humans, the developing embryo takes in oxygen and produces carbon dioxide. The shell's pores, in addition to regulating the evaporation of water, also allow oxygen in and carbon dioxide out. Because the

developing eaglet's lungs do not work until just before hatching, the chick's "breathing" is done directly through the chick's external membranes and its shell.

How Does the Eaglet Know When to Break the Egg?
The carbon dioxide builds up more quickly than it can be passed out of the egg. But this build-up plays an important role. When carbon dioxide reaches a certain level, it causes the embryo's neck muscles to twitch. This forces its beak to break through a then membrane into the air sac, and the chick takes its first breath, still inside the intact egg. After a while, this air becomes unbreathable, and when the carbon dioxide level gets high enough, it stimulates even stronger neck jerks, which cause the beak to break through the shell (known as "pipping.") The eaglet crouches in the egg in a coiled position, so the contractions also cause the eaglet to turn slightly. As a result, the next "pip" at the shell is just alongside the first hole, and so on until the eaglet breaks off the top of the egg.

Bacteria:
The pores allow for the movement of water, oxygen, and carbon dioxide; they also can allow bacteria into the egg. Since there is a sucking in of air as the egg cools after laying, eggs are most susceptible to infection in the period right after laying. They are also susceptible if the egg is dirty or too wet.

Other Birds:
Not all bird species have the same size or number of pores. The eggs of birds that lay in rocky or dry environments are not very porous because too much evaporation would kill the embryo. However, birds in damp environments (for example, ducks) lay quite porous eggs, because too little evaporation would also harm the developing chick.

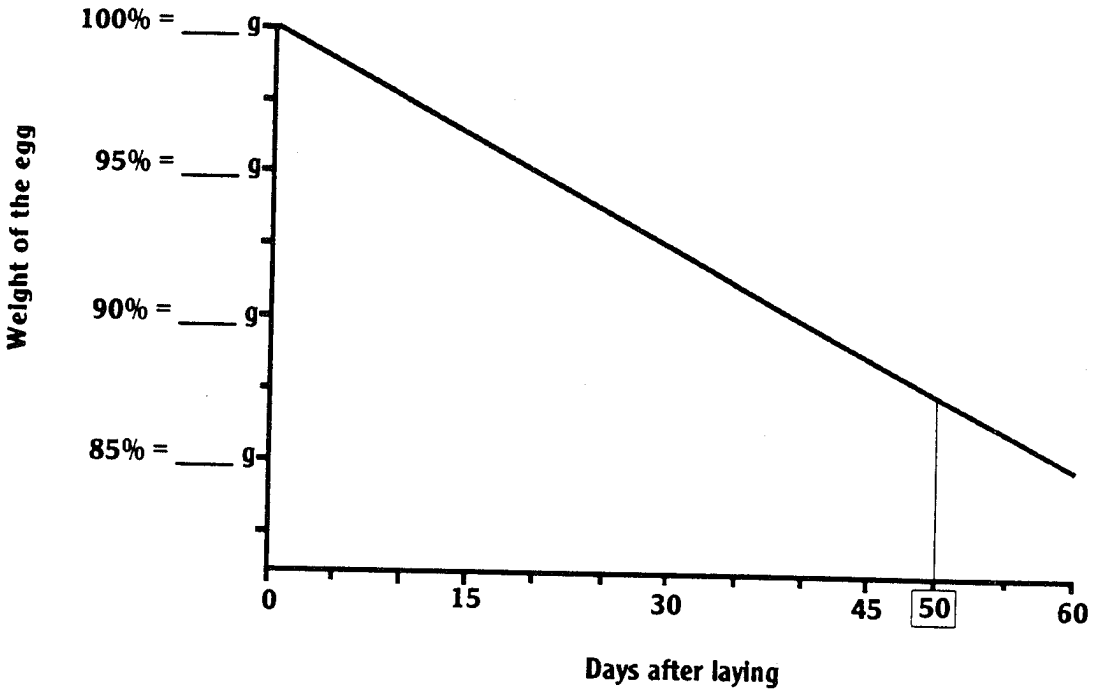
What All This Means for Caretakers of the Philippine Eagle:
In the artificial incubating chamber (birthplace of both Pag-Asa and Pagkakaisa,) the evaporation of water through the shell's pores is controlled by the humidity of the egg's surroundings. The best way to know if the embryo's water is evaporating properly is to constantly monitor the weight of the egg. If the weight is higher than it should be

(in other words, if it hasn't lost enough water,) then conditions are too humid; if the weight is lower than it should be, then conditions are not humid enough.

Check for Understanding:
Here's the situation: You are the technician assigned to take care of the Philippine Eagle egg. You have just woken up; it's 4 am and it's time to monitor the rare egg in your care. It's the 50th day of the incubation period, so in perhaps a week if everything goes well you should be holding a brand new eaglet in your hand. You read the temperature and humidity of the incubation chamber, and then carefully weigh the egg. The egg weighed 190g when it was laid; today it weighs 175 grams.

Construct a chart similar to the one below to help you determine whether you should (a) increase the humidity of the chamber; (b) lower the humidity; or (c) leave the humidity as it is.

Chart of the Correct Philippine Eagle Egg Weight



7. Imprinting: "HE's Your Husband?!"

Many newspaper articles about the Philippine Eagle mention that the eagle "mates for life." How accurate is this assertion? Eagles do tend to stay with the same mate, year after year, travelling in each other's company throughout the year, even during the non-breeding season. The eagle will, however, take a new mate if its mate is killed, or dies, or if for some reason the birds are out of each other's company for a lengthy period of time.

Ideally, captive Philippine Eagles will find attractive mates among the other eagles in the breeding center, will form a strong bond, and will produce offspring naturally, which can be released back into the wild. With so few eagles in captivity, however, some birds do not find an appropriate mate, and match-making is very difficult; if a male Philippine Eagle is placed in a cage with a female before he has been accepted, the larger female will attack and probably kill the intruder into her territory.

One of the techniques for breeding endangered animals, therefore, is "**cooperative artificial insemination**," where the animal "imprints" on a human, who then serves as the bird's mate. A human surrogate mate for a male eagle collects semen from the bird and passes it on to another caretaker who is the human surrogate mate for a female eagle, who can then inseminate the bird. If the timing is just right, the female will lay a fertile egg.

But how on earth can a human convince a huge bird of prey that he or she is the bird's mate?

"**Imprinting**" is the process of developing a relationship between a captive animal and a human for the purpose of artificial captive breeding: in a way, it is a form of courtship between two different species—humans and eagles.

One of the people with the responsibility of imprinting at the Philippine

Eagle Breeding Center in Malagos is Ben. He has become the surrogate mate of two male eagles, Junior and Jing-Jing. A tremendous amount of patience and perseverance is needed to imprint an eagle, to convince him or her that you are a desirable eagle mate. When imprinting a bird, Ben must visit the new bird every two hours, first spending time outside of the cage, sometimes feeding the eagle through the bars of the cage with a piece of meat on the end of a stick. If Ben were to enter the cage before the eagle accepted him, he would be attacked with the full weight of the bird's 5 to 6 kg and huge talons the size of a person's hands.

On about the sixth day of this regular attention, the eagle has become accustomed enough to Ben's presence that he can carefully enter the eagle's small holding cage—keeping in mind at all times that the eagle can attack and possibly kill him at any moment. After a week of careful imprinting behavior on Ben's part, the eagle will signal that it has accepted Ben's presence with "identification vocals:" high-pitched cries of "shak-shak-shak." After one to two months of socialization, Ben knows if the bird has accepted him as his mate.

Even after many years of successful imprinting and daily visits, Ben always maintains eye contact with the eagle when in the cage, even walking out of the cage backwards to avoid a sudden attack. Whenever visiting the birds, Ben wears a heavy leather jacket with a hood. This provides some protection should the eagle attack, but it also helps the imprinting process by giving him the same appearance every day. And, if something should ever happen to Ben, someone else will have an easier time taking his place if he can put on Ben's jacket.

The imprinted bond between Ben and his eagle mates is so strong that it can overcome the desire for freedom from its cage: One morning, Ben removed Junior from his cage so the cage could be cleaned, and put him on a stump; the bird's leg, he thought, was safely attached with a leash to the stump. When Ben finished the job and returned to the stump, however, he found that the leash had broken and Junior had flown into the branches of a nearby tree. Ben rushed to put on the leather jacket and stood next to the stump. Junior immediately flew down and landed on the stump, and then without hesitation climbed onto Ben's leather gauntlet, and allowed himself to be put back into his cage.

8. The Breeding Season: What Triggers the Clock?

In temperate parts of the world (that is, in the northern and southern regions above and below the tropics,) birds tend to breed at fairly uniform times of the year. In Eurasia and North America, for example, different bird species all tend to breed in the spring. Biologists trying to determine what triggers breeding in birds discovered that by altering the amount of light, they could either delay or advance the time when the birds would breed and lay eggs. When breeding cycles are regulated by the amount of light, this is called "photoperiod."

The farther one travels from the equator, the greater is the range in the amount of daylight at different times of the year. In Britain, for example, in the summer month of July daylight lasts from four in the morning to past ten at night; in the winter month of December, the skies are completely dark by five in the evening. Here in the Philippines, because we are closer to the equator, there is not much variation between our longest and shortest days. If not photoperiod, then what does trigger the breeding cycles of our birds?

There are many factors which need to combine to trigger breeding in bird species, but often there is one factor which dominates. Remember that breeding cycles evolve so that species can take maximum advantage of the conditions around them; if an animal has the genes which trigger breeding at a time of the year when its young is most likely to survive, then this gene will also survive and be passed down to succeeding generations. On the other hand, if the animal's genes trigger it to reproduce at a time when conditions are not optimum, then few if any of its offspring will survive, and the gene will not be passed on to the next generations.

Here is some information to help you determine the tropical alternative to photoperiod:

- ❑ The Philippine Eagle usually begins breeding activity in September, and lays eggs between October and December. (Incubation time is approximately 57 days.) Pag-Asa hatched in January and Pagkakaisa in December.

- ❑ Although September usually marks the beginning of breeding activity for the Philippine Eagle, there is variation. In 1995, the eagles in the breeding center were observed to start their breeding activity in mid-July.

- ❑ Not all bird species in the Philippines have the same breeding season. The Philippine Falconet, a tiny raptor (15-18cm; 37-52g) which feeds mostly on insects, has a breeding season which usually lasts from March to May.

Phil. Falconet

Guiding Question: What fluctuating environmental signal in the Philippines would be most useful to help a bird species know when to reproduce?

The Eyes of a Raptor (II)

Birds of prey have **three eyelids**: one closes from the bottom, one closes from the top, and one closes from front to back. This last eyelid is semi-clear and it is usually closed when the bird is flying (to prevent the eye from drying out in flight,) and when attacking, (as an added layer of protection.)

9. What's the Dirt on Siltation?

On November 5, 1991, typhoon Uring passed near Ormoc, on the northwestern coast of Leyte. Although the typhoon was not particularly strong, with top wind speeds of perhaps only 70km/hr, the typhoon did bring with it very heavy rainfall as the wet winds from the northeast collided with winds from the southwest and were forced to climb the mountain range of Leyte. It was a severe storm, depositing between 300 and 400mm of rainfall, but it was the kind of storm which strikes the region perhaps every 50 years—that is, once or twice in one person's lifetime.

This time, however, the storm brought with it tremendous destruction, a flash-flood which left over 8,000 of Ormoc's 120,000 people dead.

Why did this storm wreak such havoc on a settlement which had survived much worse storms, typhoon season after typhoon season, for hundreds, perhaps thousands, of years? The answer has to do with a combination of factors involving the geology of the region and the changes which humans have brought to the land.

- ❑ Ormoc sits on the coast between the mouths of various rivers which drain the area into Ormoc Bay.

- ❑ The slope of the land along the coast where Ormoc is located is very gentle, with an inclination of 1-5%. The land then becomes steeper as it reaches up to the mountain range (with an elevation of 1000m), where the inclination is approx. 50%.

- ❑ The soil near Ormoc is largely made up of sand and silt. (Why do you think this is so?) The soils in the high slopes above Ormoc are mostly clay. (What is the significance of these details?) On the high slopes above Ormoc, the land has been cut into deep canyons.

- ❑ In the lowlands, rice is grown along the rivers. Most of the rest of the land is used for farming sugarcane, even up to 600m elevation on the slopes of the mountains. On the highest elevations, cogon grass is dominant. Kaingin farming has moved farther and farther up the slopes; secondary forests are prevented from growing in cleared fields. Only on the very highest mountain ridges does some primary forest still exist, though logging has been occurring. Aerial photos taken in 1973 and 1988 show that deforestation took place in just 14 years.

- ❑ The flow of the rivers which come down from the steep mountains above Ormoc is normally very fast. (This would have what effect on the shape of the rivers—would they be wide and shallow or narrow? Why is this a significant detail?)

Reconstruct the situation in Ormoc on November 5th in a drawing (e.g., a cross-section) showing as much of the above information as possible. Underneath the drawing, **explain** the significance of as many of these details as you can.

The link between deforestation, lowland farming methods applied to sloping land, erosion, and dramatic effects on the ecosystem can be seen in the following simple experiment:

Materials:

- Two long basins or trays, made of plastic or other waterproof material.
- Enough soil to fill both basins.
- Enough various live plants to fill one basin.
- Two clear glass or plastic tanks.
- Two large water containers, with small holes punched in the bottom.
- Some goldfish and/or waterplants.
- Optional: Two small aquarium water pumps, with plastic or rubber tubing.

Fill both basins with soil. Plant one with sods of grass or other plants. Allow the roots of the plants a week to establish their roots. Set up the two basins at the same steep angle. These represent two mountain slopes.

At the bottom of the basins, set up the two clear tanks so water can run off into them; fill them with water and place a few goldfish and/or waterplants in each, if available. Fill the top containers with water and time how long the containers take to empty (they should empty at approximately the same rate.) Arrange a schedule so that someone fills the top containers with water from the bottom tanks whenever the top containers near empty. Make sure that the tanks don't get mixed up; each set of container, basin, and tank represents a separate water cycle of rainfall, run-off, and evaporation.

(If aquarium-type water pumps are available, arrange the pumps and tubing so the water from the lower tanks is drawn up and pumped into the upper containers (with the holes.) Make sure the rate of the water going into the top containers is not faster than the rate of water dripping out—or you'll have a real flood in the classroom.)

Observe the condition of the different elements of each water cycle: the state of the soil, the water in the tanks, and the waterlife.

- Summarize your observations.
- What effect does the loss of plant cover have on mountain slopes?
- How does this effect farmers in the long run?
- What effect does the loss of plant cover have on rivers? On lakes? On drinking water? On reservoirs which power hydro-electric plants?
- What effect might the loss of plant cover in the mountains have on life in the ocean?
- What effects would be felt by (a) upland farmers? (b) lowland farmers? (c) fisherfolk?
- Identify at least five ways in which **your** life is affected by soil erosion in the uplands.

10. Watersheds: Where Does That Glass of Water Come From?

Why Do Watersheds Matter?

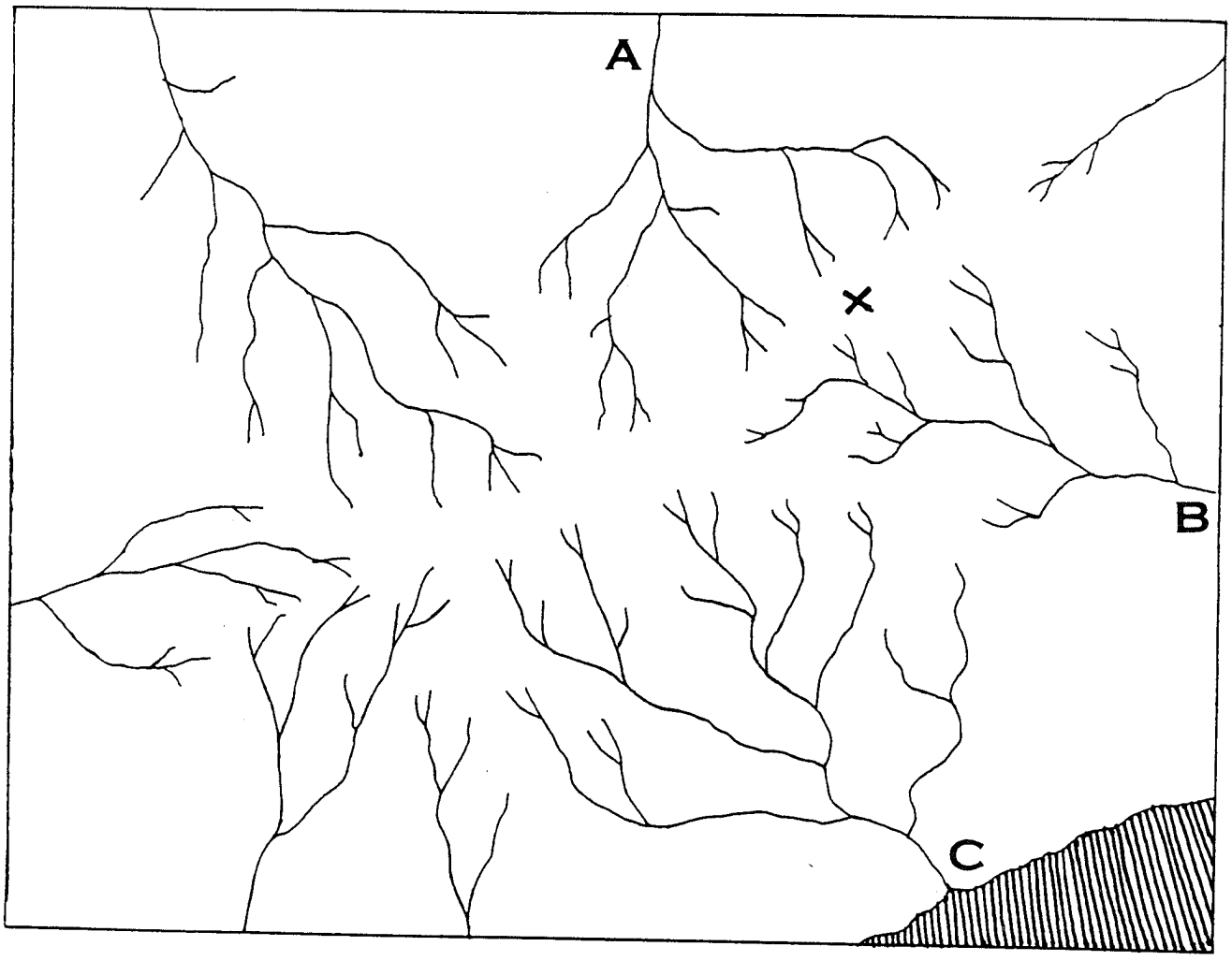
Understanding watersheds is important because a watershed is an interrelated system in our ecosystem. When there is a problem with one distant part of the system, it effects the whole system, which includes the plants, animals, and people who are a part of the system as a whole. Understanding what watersheds are and how they work gives us a better understanding of the relationship between water and the land, and of the power people have to disrupt the supply of clean, plentiful water on which we all depend, for irrigation of our farms, for drinking water in our reservoirs, and so on.

Definition: What is a Watershed?

From looking at the map of rivers below, can you tell which direction each river is flowing?

If you put an arrowhead on each river, you will notice that some places act as divisions between water flowing in different directions. For example, the river at point A is flowing north; the river at B is flowing east; and the space X between them marks the divide between the area drained by river A and the area drained by river B.

Find the mouth of the river which is marked with C. Draw a dotted line around the area which is drained by that river. In other words, find the divide between the river systems. This area is the **watershed** of the river C.

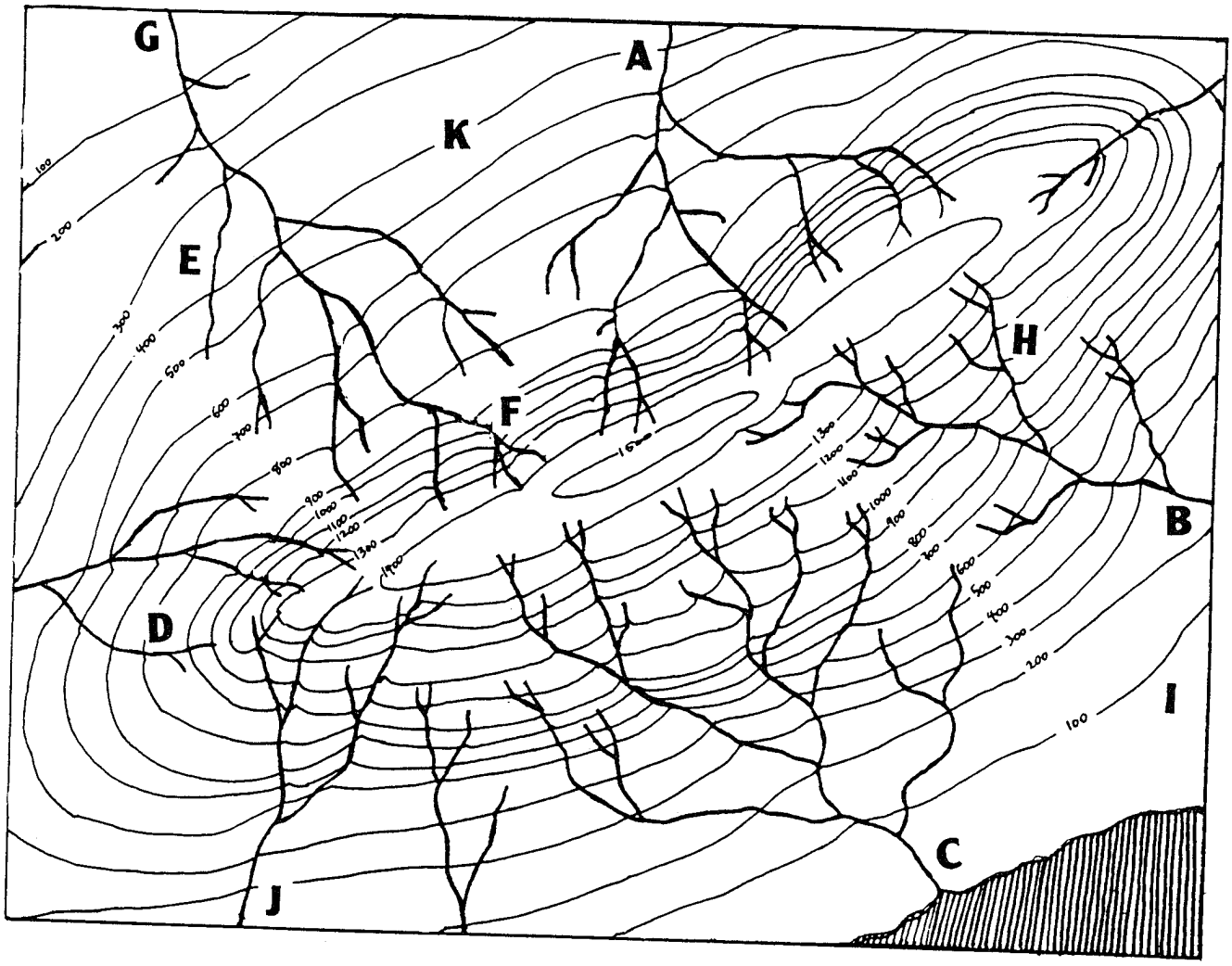


The Relationship Between Land and Water

Take another look at the map of the rivers. Knowing only where the rivers are, what can you say about the shape of the land? With your partner(s), write down some things that you can infer about the shape of the land based on the pattern of rivers. ("Shape of the land" includes height, slope, location of mountains or hills, and so on.) Where would you infer are the highest points on the map? The lowest? Be prepared to justify your inferences to the class.

Watersheds and Topographical Maps

Below is a map of the same area as on the previous page. Lines of elevation have been added to turn the map into a "topographic" map—that is, a map showing the height of the land. Does the topographic map confirm your inferences about the shape of the land? Where were you correct, and where incorrect? What further information about the watershed is available when you know where the lines of elevation are?



- Rank streams D, E, and F from fastest-flowing to slowest. Explain the reasons for your ranking.
- Would the water flowing out of mouth C be slower or faster than the water flowing out of mouth J? Why?

The Watershed Map and Human Decisions

Based on what you have learned so far about watersheds, how would you answer the following questions?

- Where would you infer the cleanest drinking water would be: A, G, or H? Why?
- On this map, all land over 1100m is primary forest. If this forest were clear cut, which rivers would be effected by siltation?
- You discover that clear-cutting of the forest is taking place. You would like to build a house for your family. Where would you choose to build to protect your family from flash-flooding: C, I, or K? Why?

The Eyes of a Raptor (III)

If you stand eye-level to a friendly Philippine Eagle (that is, one that's used to people,) it will frequently turn its head upside down to look at you. It's not doing this to be entertaining. Because a flying or perching eagle needs to search **downwards** for its prey, its eyes have evolved so that the lower part of its eye is the most sensitive. By turning its head upside down, it's just getting a better look at you.

Also: an eagle studying you will constantly move its head back-and-forth and side-to-side. It's not nervous from drinking too much coffee; the movement just helps the eagle to focus on an object.

11. Disrupted Ecosystems: The Golden Apple Snail in the Philippines

An **ecosystem** is a delicately balanced world which has evolved over millions of years; a world in which animals, insects, the soil, the climate, water, birds, reptiles, and even people have developed to balance and complement each other.

However, we humans have the ability to alter an ecosystem dramatically, without always knowing how the alterations will effect the system. An ecosystem can be disrupted by adding one single component—or by taking one single component away.

The Canadian naturalist Farley Mowat (in "Never Cry Wolf,") described how the great northern wolf, though feared and hunted by humans as a dangerous, life-threatening predator, was actually an important piece of the balanced natural machinery which kept all of its pieces in harmony. The wolves hunted caribou, which brought them into conflict with human sport hunters. Mowat spent many months in the cold Arctic of northern Canada and discovered that one of the functions of the hunting wolf was to actually make the caribou herds stronger, not weaker. He noticed that the wolves did not attack the first caribou they saw, but waited patiently until they had picked out a slow or sick or old or infirm caribou which became their targeted prey. By killing the weak members of the caribou population, the wolves helped to keep the caribou herd strong because, in a process continuing over thousands of years, the caribou carrying genes which make them too slow or too weak are carefully eliminated. Similarly, the wolf helps to strengthen the caribou in the long run by preventing the population from growing so large that the caribou destroys the plants which the species needs to survive, which would destroy the strong and the weak alike. Therefore, it is clear that the "predator/prey" relationship is much more a mutually beneficial "symbiosis" than a one-way relationship of exploitation.

There have been many examples of humans disrupting a delicately

balanced ecosystem for short-term goals, without knowing what unintended consequences they set in motion. In Borneo, in 1955, there was an outbreak of malaria. The World Health Organization sprayed the country with DDT, a lethal insecticide which killed the mosquitoes which spread the disease. The DDT also killed houseflies, however, which were then eaten by geckos, which were then eaten by cats. The entire food chain, balanced between predators and prey, which had evolved over millions of years was suddenly and dramatically disrupted. The rat population of Borneo exploded and now a new disease epidemic appeared, spread by rats: bubonic plague. The solution? The WHO **air-dropped thousands of cats**—by **parachute**—into the countryside (known as "the day it rained cats.") This sounds like fiction but it is not.

These two examples show how removing just one link in the ecosystem chain can seriously threaten the entire chain. In the Philippines, there is an ongoing problem which was brought about by the introduction of a new species into the chain, with equally disastrous effects. The new species was the Golden Apple Snail.

The Golden Apple Snail Story

The snail originally came from the Amazon in South America. It was introduced into the Philippines in 1982 as an inexpensive source of protein. Farmers were told that the snails could be sold to fancy restaurants in Manila for 45 pesos a pair, and that in just three months they could earn back whatever money they invested in establishing the snails, because it grows to the size of an apple in just a few months.

Farmers soon discovered, however, that the snail was a disastrous disruption to the local ecosystem. It grows quickly, reproduces at an incredible rate (one snail can produce 150,000 offspring **in one year**,) adapts to many different environments, and is very hard to kill. And what fuels their incredible growth? Unfortunately, what the farmers didn't know was that the snails love to eat **rice**. The Golden Apple Snails move day and night in search of food, and a rice-field can be destroyed by an infestation of snails in just one day. By 1989, the snail had infested 500,000 hectares of land, and in some parts of the country had eaten

three-quarters of the rice crop. It is now the worst rice pest in the Philippines, causing more damage than locusts or green leaf-hoppers.

The restaurants in Manila stopped buying the snails, and local people who doused their fields with pesticides to try to get rid of the snails were not eager to dine on them either. The pesticides also killed the small native snails which they had traditionally used in their diets.

Why is it so hard to control the snail?
Because the Golden Apple Snail evolved in a different ecosystem, no natural predators exist in the Philippines to feed on it and keep its population down. The most likely predator in the Philippines is the duck, but they are expensive, can only eat the small snails, and can not be used when the rice plants are young because the ducks will also eat rice seeds and plants. The snail is very hardy and adaptable; during droughts lasting months it can survive by burying itself in the ground, and when heavy rains come and or farmers flood the fields, the snails can easily travel from field to field. This has caused additional damage because farmers now use expensive and dangerous chemicals to kill the weeds which they used to flood their fields to eliminate.

Understandably, Filipino farmers resorted to powerful **chemicals**, called "molluscides," to try to kill the snails. Demand for the chemicals drove their price up, and from 1987 to 1990, farmers spent 250 million pesos on molluscides; by 1990, 20% of an average farmer's income was spent on molluscides. Of course, these powerful chemicals also affected farmers' health, and there have been many reports of severe side-effects, including headaches, burns, and blindness. In addition, since whole families must spend more and more time picking snails from their fields by hand (up to four hours a day at some times of the year,) there is less and less time available to work at other tasks or on other jobs which traditionally supported their incomes.

From this story of the Golden Apple Snail, you can see how the human introduction of one small, "harmless" creature can bring about dramatic, disastrous, and totally unexpected changes in the ecosystem—and in the daily lives of the people who are a part of it.

Ecosystem Assignment:

Find a nearby **natural** food chain (in other words, not a food chain like "Farmer feeds pig. Farmer eats pig.") It should involve more than three components (for example, "Tree-leaf-soil-tree" is too simple.) Base it on **observations** rather than what you have read in a book. Spend time watching plants, animals, reptiles, birds, and insects to see how they relate to each other, and take careful notes. The food chain may be in a town, in rice-fields, in the forest, on the edge of a river, at the seaside, or anywhere else you can find it. Then choose **one link** in the food chain and hypothesise what would happen if that link were eliminated for some reason. Keeping the examples above in mind, remember that disrupted ecosystems can lead to very unexpected and surprising situations. Finally, write a story as if it were written in the future, describing the chain of events which followed the elimination of that one link. It's OK to have fun with the story! Remember: Fact often turns out to be stranger than fiction.

Ooops! Take a look at that 50 centavo coin in your pocket. Of course you've noticed the Philippine Eagle on the back before—but did you ever notice the spelling mistake in its Latin name? When the coins were first minted, the name was written as "Pithecobhaga jefferyi." Later coins are printed with the correct "Pithecophaga jefferyi."

12: What Price a Tree?

How much is a tree worth? There are many ways to answer this simple-sounding question, because there are many different ways to calculate value.

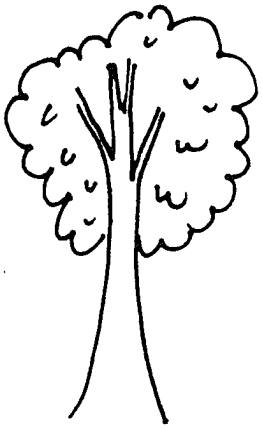
One Way to Calculate the Value of a Tree: The Value of its Lumber

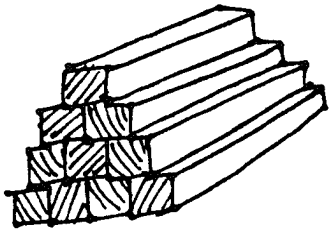
One way to calculate the value of a tree is to estimate how much money you could sell the tree for if it were cut up into lumber. Choose a large tree near your home or school to "adopt." Find out what kind of tree it is. Then find or estimate the answers to the following questions. Some answers you will need to do research to find; others you will have to make a good estimate to get an approximate answer.

- ❑ How much does a length of cut lumber cost in your neighborhood? Ask someone who sells wood or ask a carpenter the cost of lumber from the tree you've chosen (pesos per meter, for example.) You will need to use the figure to calculate the value of the lumber in cubic measurements (for example, a board one meter long and half a meter wide will cost more or less depending on how thick it is.)

- ❑ Measure the circumference of the tree you've chosen. Because the trunk is usually much thicker at the base, use a somewhat smaller number as an average trunk size for the whole tree. Estimate the tree's height. Don't include small branches or leaves; you can't use them for making lumber. Then calculate the **volume** of the lumber wood in the tree.

- ❑ Use the information you gathered about the peso value of lumber and the information about the approximate volume of the adopted tree to calculate the peso value of the tree.



=  = ₱ _____

What is Left Out of the Value Calculated In This Way?

The calculation you made above will provide you with the value of the wood of your tree, or how much the tree would fetch if sold in the market as cut wood. But does this way of figuring the worth of the tree include everything of value which the tree has to offer? The next activity requires you to think about what the above equation leaves out.

Process: The teacher will divide you into teams. One person in each team will be the note-taker. You will be given three minutes to write down as many things as you can think of to answer the question: What is left out of the value of a tree when you only calculate the value of its lumber? Your goal as a team is to think up an answer which no other team has thought of; your team will get a point for every unique answer.

Why is it Difficult to Measure Worth?

Look at the list which the class has generated in just three minutes, and imagine how long the list could be if you had more time to add to it. You'll be assigned some of the things from the list to put a peso price on.

Why are some things hard to put a price on? Was it easy to decide among the members of your group?

Some people believe that all value and worth can be measured in peso terms—what are some of the problems of relying on markets to set prices on valuable things like trees?

13. Indigenous Filipino Views of the Land

The Idea of "Ownership" in Traditional Filipino Society

In the Philippines today, there are basically two categories of land: privately-owned land and state-owned land. These are the types of land which have a legal existence in the laws of the country. Although it is sometimes hard to imagine any other way of looking at land, these two categories, private and state-owned, do not represent the only way that land has been seen in the Philippines. There have been other ways of viewing the relationship between the land and the people, ownership, land use, control of natural resources, and so on.

Ideas of "ownership," like all ideas, have a history—in other words, they do not exist as natural facts for all time, but change over time and from society to society. An example of this is the legal existence of slavery; at certain times in certain societies it has been acceptable for one person to have legal ownership over another person, to buy and sell that person on the market, and to use that person's labor for their own profit. There have been in such places legal categories of "free person" and "slave." In most parts of the world, such slavery no longer has legal existence.

In a similar fashion, various conceptions of ownership of land and categories of land use are also constructed differently, by people, in different places and times. The current system of land ownership dates

back to the arrival of the Spanish in the Philippines in the sixteenth century. Using a notion which they brought over from Spain, the Spaniards declared that all land not individually titled (a "title" is a document proving that a person owns something,) belongs to the King of Spain—in other words, that all untitled land belonged to the state. The Spanish also introduced the idea throughout the archipelago that land can be bought and sold. When the United States arrived in the Philippines and governed the country as its colony, it continued the basic assumptions of this Spanish legal practices.

What kinds of conceptions of land ownership and land use existed in the pre-Hispanic Philippines? In many parts of the Philippines, from Mindanao to Luzon, there was a traditional idea of land ownership which is very different from the one present in the legal system of the Philippines. Let's take a close look at one such system—that of the Kalinga people of northern Luzon.

The Kalinga people practice wet-rice and swidden agriculture on very steep mountainous terrain. The steep slopes require terraced rice-fields, the building of which in turn requires communal effort. An individual could not survive long working alone. Common community relationships have been extremely important, and the sense of common community has influenced how the Kalinga view the ownership of land and how it is to be used responsibly.

Traditionally, they have divided their land into six categories, determined by how the land is used. These categories are:

Limited Individual:
1. residential land (homes)
2. rice terraces

Communal:
3. swidden farms (kaingin)
4. forest areas (wood, food, medicines, etc.)
5. pastures
6. tree farms (for timber or orchard fruit)

Although they have these distinct land and resource categories, the Kalinga traditionally have recognized the inter-relationship of the land types. Many have argued that this system is an example a balanced people/nature ecosystem which has worked. They have shown awareness, for example, of the importance of resource security, and an understanding, for example, of the relationship between the watershed and the placement of their rice-fields.

"Limited individual ownership" means something different from the idea of "private property" which currently exists in law in the Philippines. It means that within Kalinga society, you have individual control over, for example, your home, or over the rice terrace which you built on the slope of a mountain. You may pass your property down to your daughter or your son, (usually when they marry,) but there is strong social pressure against selling land, because it is in effect stealing someone else's inheritance. In certain emergency situations, land may be "sold," but it must first be offered to the relatives. It must never be sold to someone outside of the community. If you do sell the land to a family member, you maintain forever the right to buy it back. The Kalinga tradition recognize individual's private rights, but they are always subject to communal decisions. So the notion of titling land so that no one has claim to it but the owner—this is a concept which doesn't exist in traditional Kalinga society.

"Communal" resources are those which are available to anyone in the community; no one in the community can be denied the right, for example, to hunt in the forest, cut firewood, or pasture animals. What you take from these common resource areas is for you to use as you see fit; the Kalinga believe in the principle that you may prosper from the fruit of your labor. For example, if you spend all day gathering firewood in the communal forest, that firewood does not belong to the community as a whole. At the same time, in traditional Kalinga society, people did not pay each other to help them planting or harvesting or building terraces or a house; there was the belief that you should help your neighbor when they needed your help, and there would soon come a time when you would need their help in return.

14. Biodiversity vs Uniformity

Background Reading on Biodiversity:

When the American car-builder Henry Ford started using an assembly line system to make cars, other industries quickly followed his example. Factory owners found that an assembly line, with uniform parts and each worker having a very limited role in the assembly process, allowed them to make more cars more quickly and for less money.

The model of the assembly line has been applied to many other areas of life, including farming and forestry. In "monocropping," ("mono" = "one,") a large farm grows just one variety of, for example, wheat. What might be the advantages of such a farm, in terms of planting, harvesting, fertilizing, and so on?

But monocropping replaced earlier farming systems which have been in existence for thousands of years. The opposite of monocropping is the system in which a variety of different plants and farm animals are raised alongside each other. These traditional farming systems, common in the Philippines, evolved over many centuries of trial-and-error to produce farms where different species have formed helping relationships with each other. Such a helping relationship is called "symbiosis." Although farmers did not have access to modern scientific knowledge, they understood that the variety of life on their farms was a positive quality, not a disadvantage.

What are the advantages to having diversity of life over uniformity?
In Negros, traditional farms were replaced with large sugar plantations, with hectare after hectare of the same crop of sugar cane making planting and harvesting with machinery easier. The sugar was exported to earn cash for the plantation owners; but when the world price of sugar dropped, those who relied on the sugar for their livelihoods suffered a great deal, and they had no other crops to fall back on for survival.

As the Indian writer Vandana Shiva has pointed out, in the last half

century, India has grown over 30,000 indigenous varieties of rice. But because of intensive breeding efforts, it is predicted that this huge genetic diversity will be reduced to just fifty varieties, with three-quarters of all rice grown in India consisting of just ten varieties.

Why should this loss of diversity disturb us? Isn't it easier to farm just a few varieties of such crops, throughout the world, than to have so many different varieties with different characteristics to deal with? Actually, greater diversity in plant, animal, and insect varieties adds to overall stability. Many of the most widespread varieties of rice, corn, and wheat were developed by scientists breeding from just a few original varieties of these plants. The result has been a dangerous situation for the world's food supply: When you have a smaller genetic base, one pest species can appear and destroy huge amounts of produce. A diversity of crops rather than monocropping allows the land to "heal," because pests tend to feast on one crop; planting the same species season after season allows the population of the pest particular to that crop to grow unchecked. If you have a variety of crops, you also have a variety of pests and a variety of plants, animals, and insects which feed off of each other, keeping any one population in check and preventing it from growing so large that it endangers the food supply.

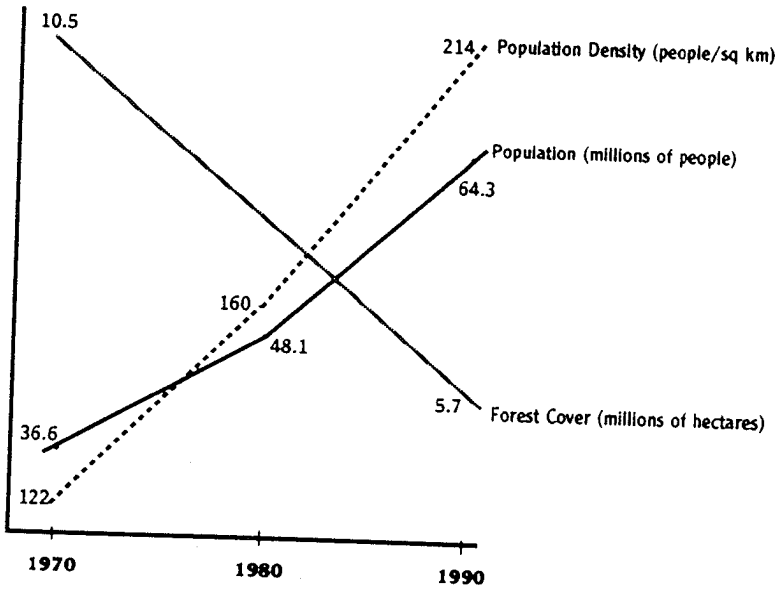
15. Population & Deforestation

Is Too Many People the Problem?

The population of the earth has grown considerably over the past century, and so has the extent of environmental destruction. This is true in the Philippines as it is true for the world in general. Is there a connection between the two? Is it true, as some people have argued, that there are just too many people for the earth to comfortably support us all?

What are the arguments which seem to support this view? What evidence

might be used to support these arguments? Below is a graph which might be used as evidence by those who support this view of the relationship between deforestation and population:



Population and Deforestation in the Philippines

What arguments are opposed to this view? What evidence might be used to cast doubt on the view that overpopulation is the root cause of deforestation?

Below are some situations and questions which should help you to think critically about some issues surrounding population and deforestation:

1. Country A has a population density of 327 people per square kilometer. Country B has a population density of 94 people per square kilometer. Both began with a similar amount of original forest cover. Which country do you think has kept forests on over 63% of its land area, and which has kept just 2%?

2. Region C has a population of 30 million people and a population density of 57 people per square kilometer. Country D has the same land area but double the number of people.
   Which of these areas would you guess has cleared more than 80% of its original forest cover?

3. Which deforestation rate would you anticipate for each country in the chart below?

Country:	Population Increase:	Deforestation Rate:
E	1,400,000 per year	
F	450,000 per year	
G	90,000 per year	

Deforestation Rates:
(a) 1,000 sq km per year
(b) 2,500 sq km per year
(c) 3,500 sq km per year

4. Country H has a population of 250 million; Country I has a population of 800 million. Which country do you think uses more paper?

Finally....
Can you identify the places which are mentioned in the cases above? Choose from this list:

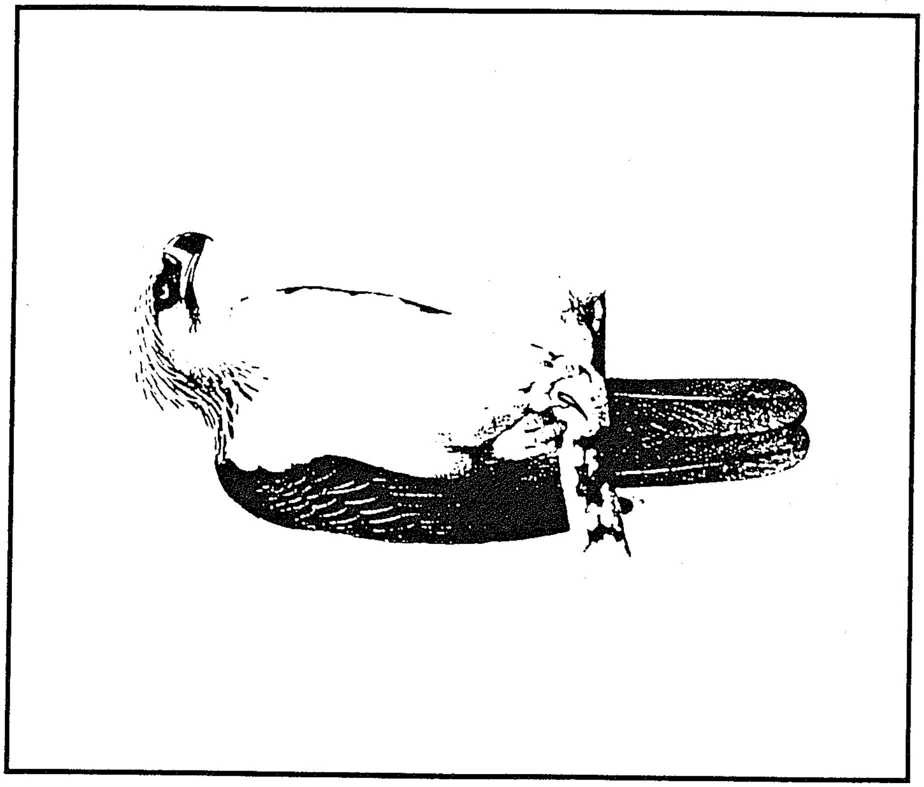
Peru	France	Central America
USA	Japan	Papua New Guinea
India	Cuba	Vietnam

Appendix: Connections Cards*

The following pages contain templates for cards which can be used in a variety of ways. Cut out and laminated, they can be used to create a simple game of connections, similar to the game described in the last chapter of the Teachers' Guide—in other words, people take turns turning over a card, and must make some connection with the card which the person immediately before them had chosen. If multiple copies of each card are made, there will be more opportunities to make many connections, which is the object of the exercise.

* Thanks to Reinita Navarro for help in developing this game, and to Rosela Gementiza for the translations.

AGILA



THE PHILIPPINE EAGLE

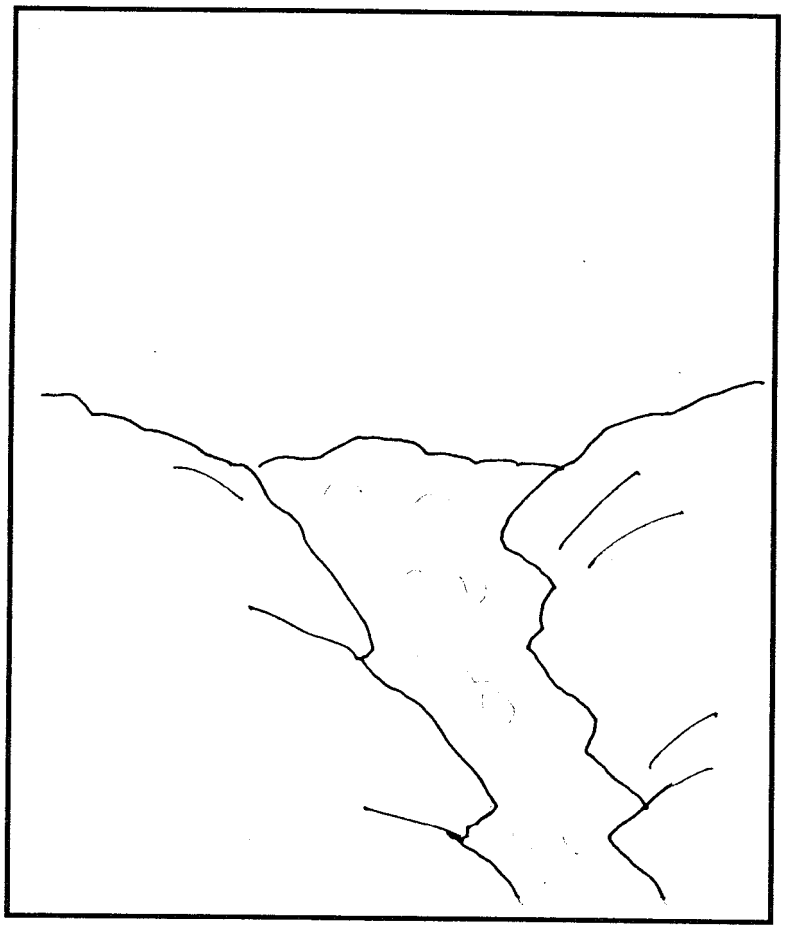
AGILA

ANG KAGUBATAN

THE FOREST

ANG KAKAHUYAN

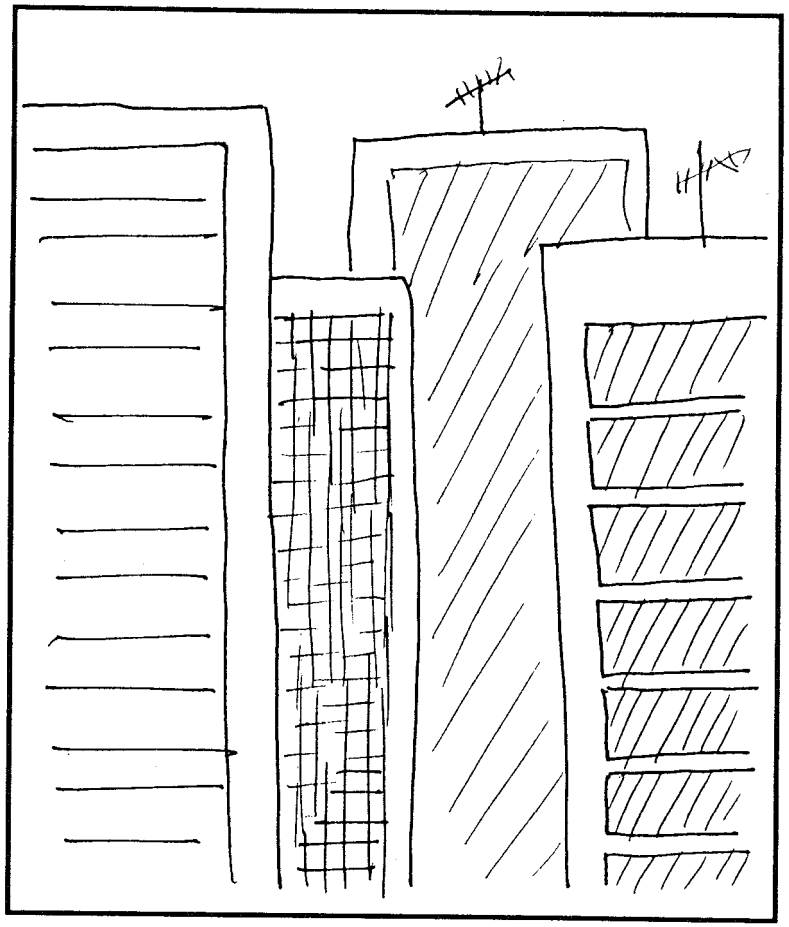
Soil Erosion



Pagpagas sa Yuta

Pagpagas sa Yuta

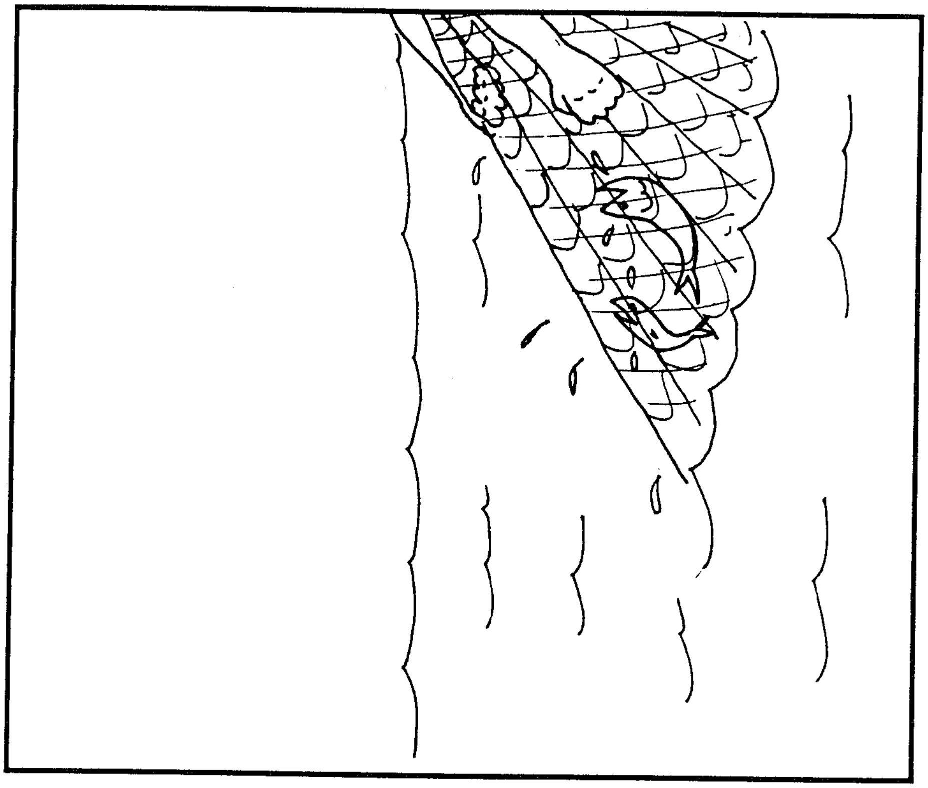
The City



Ang Ciudad

Ang Ciudad

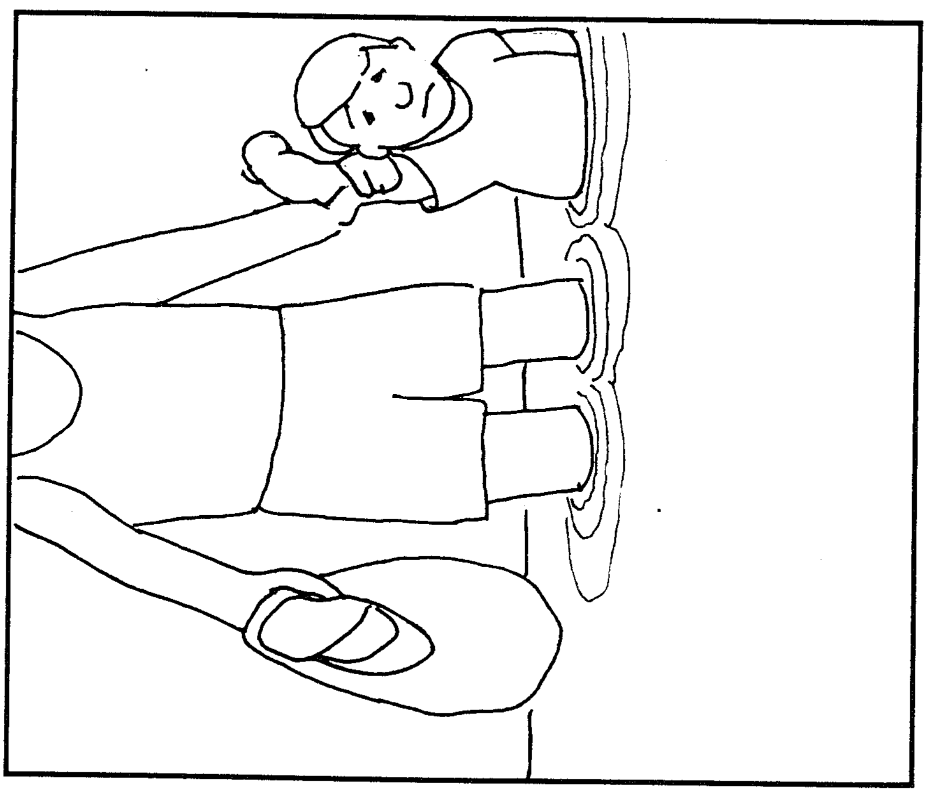
MGA MANGINGISDA



MGA MANGINGISDA

FISHERFOLK

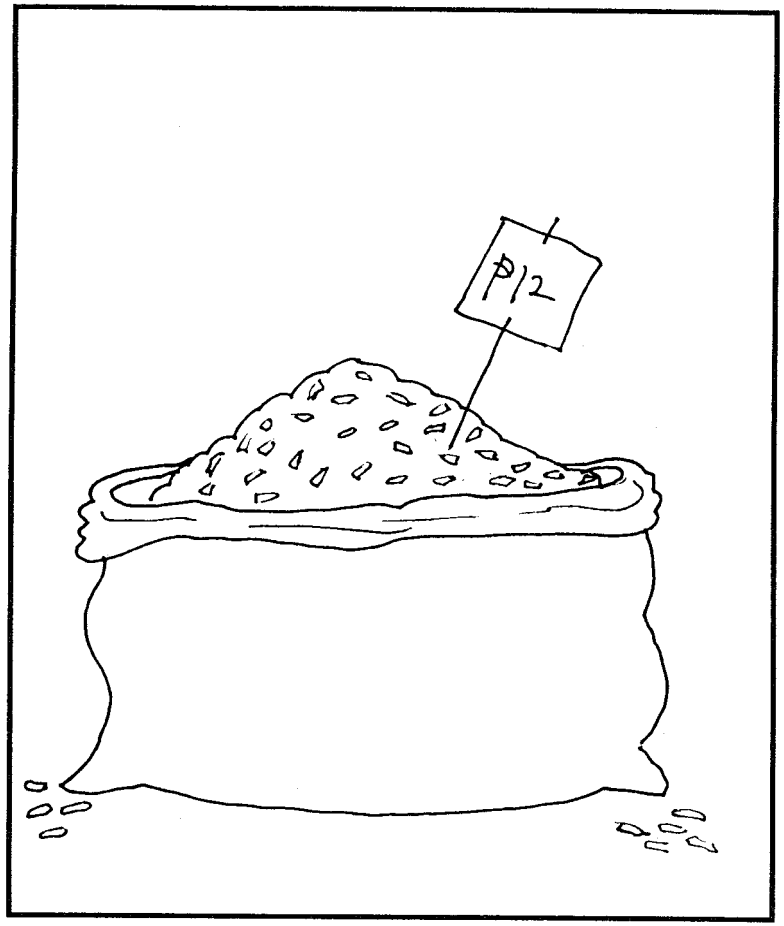
PAGBABAHA



PAGBAHA

FLOODING

PRICE OF RICE



PRESYO NG BIGAS

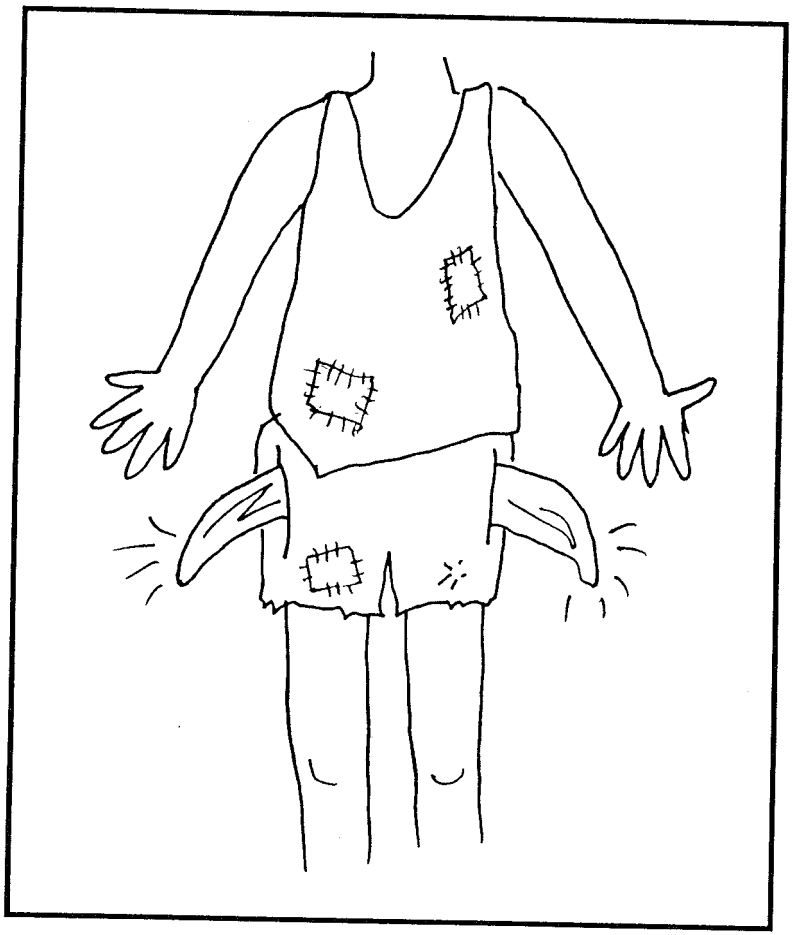
PRESYO SA BUGAS

POPULATION

POPYULASYON

POPYULASYON

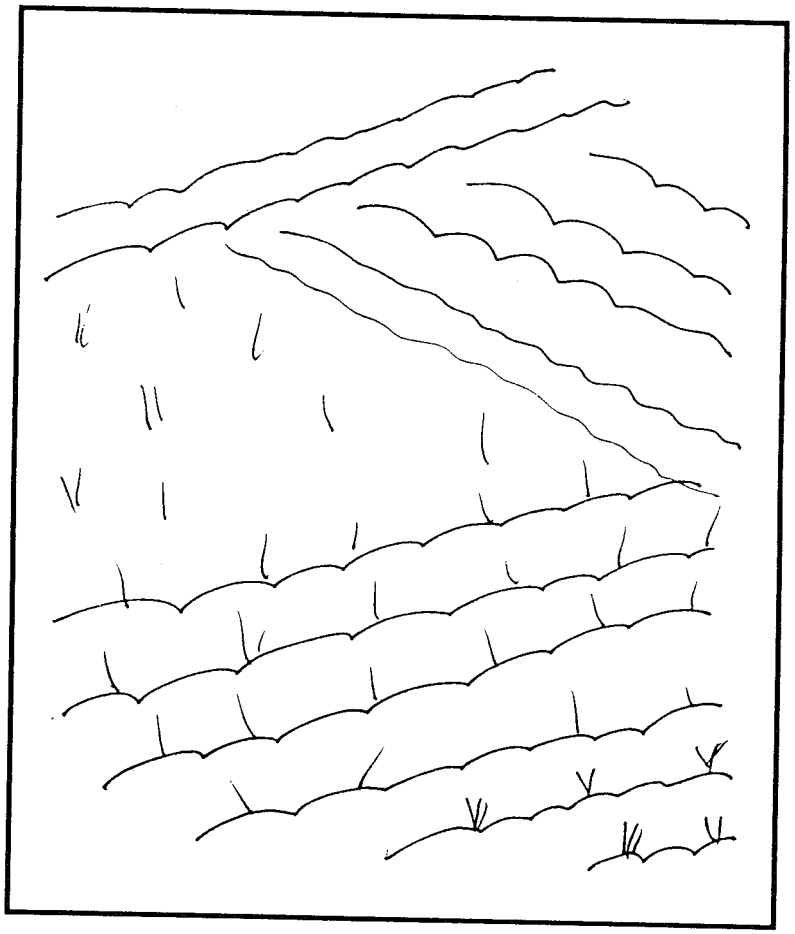
POVERTY



KAHINAPAN

KALISOD

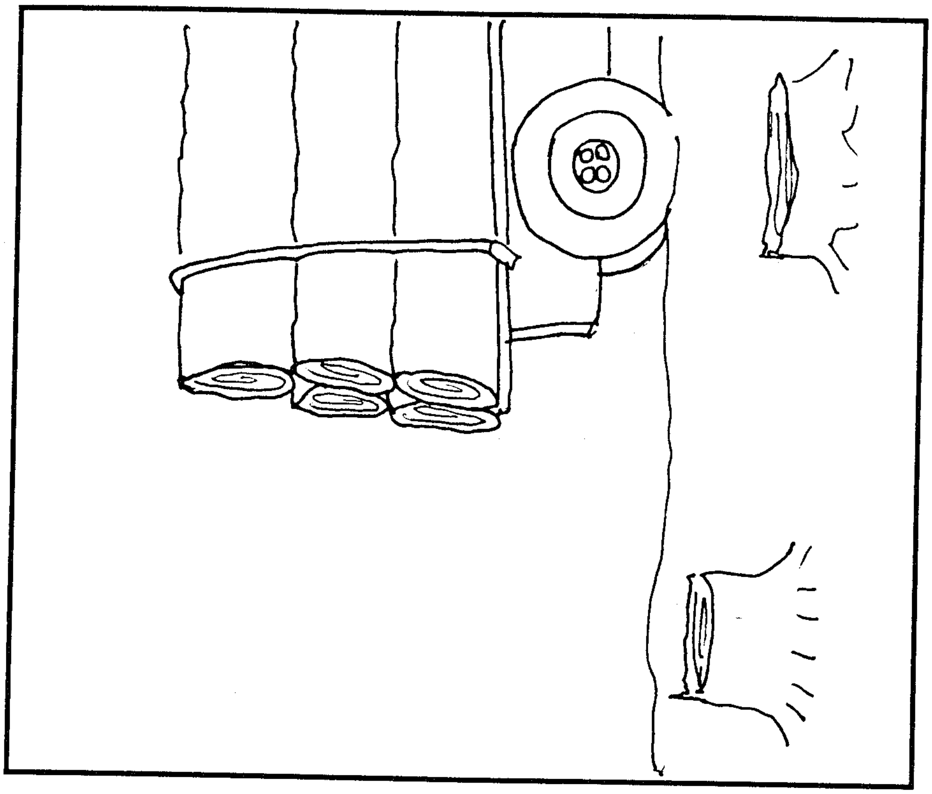
FARMLAND



SAKAHAN

UMAHAN

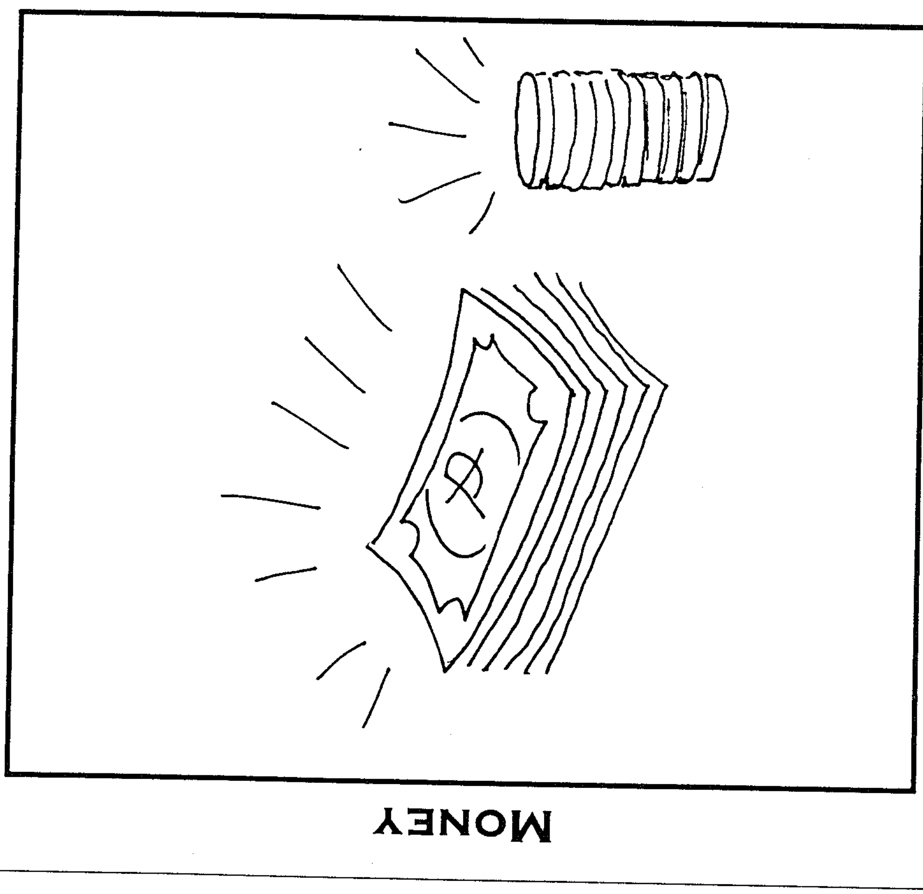
LAGING



LOGGING

LAGINAGAN

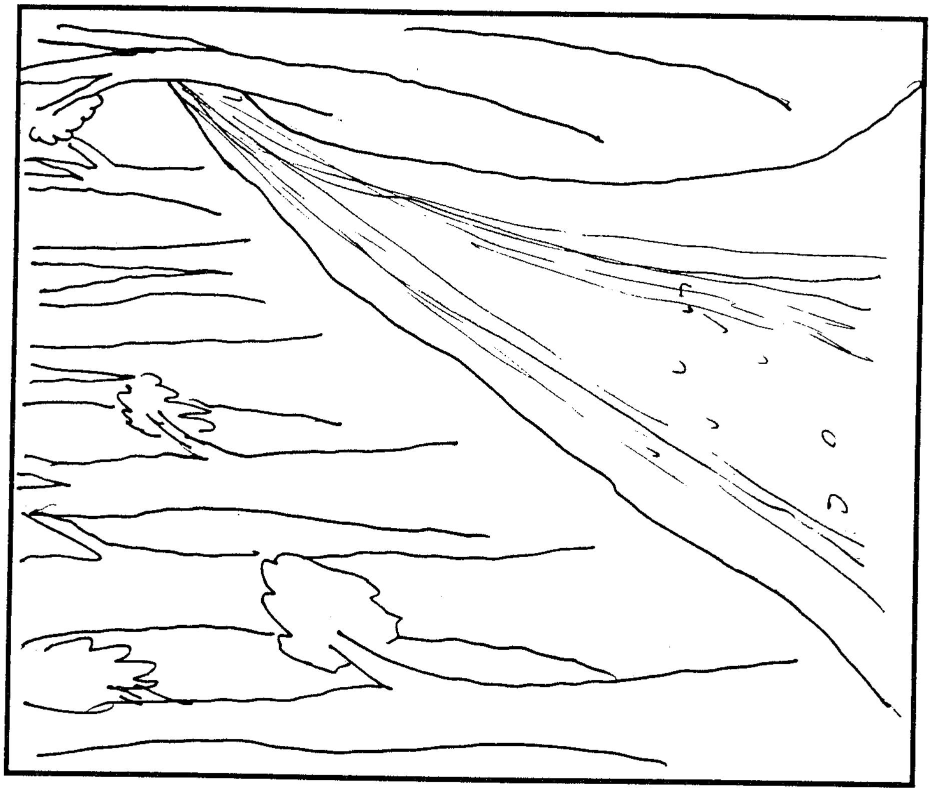
PERA



MONEY

KWARTA

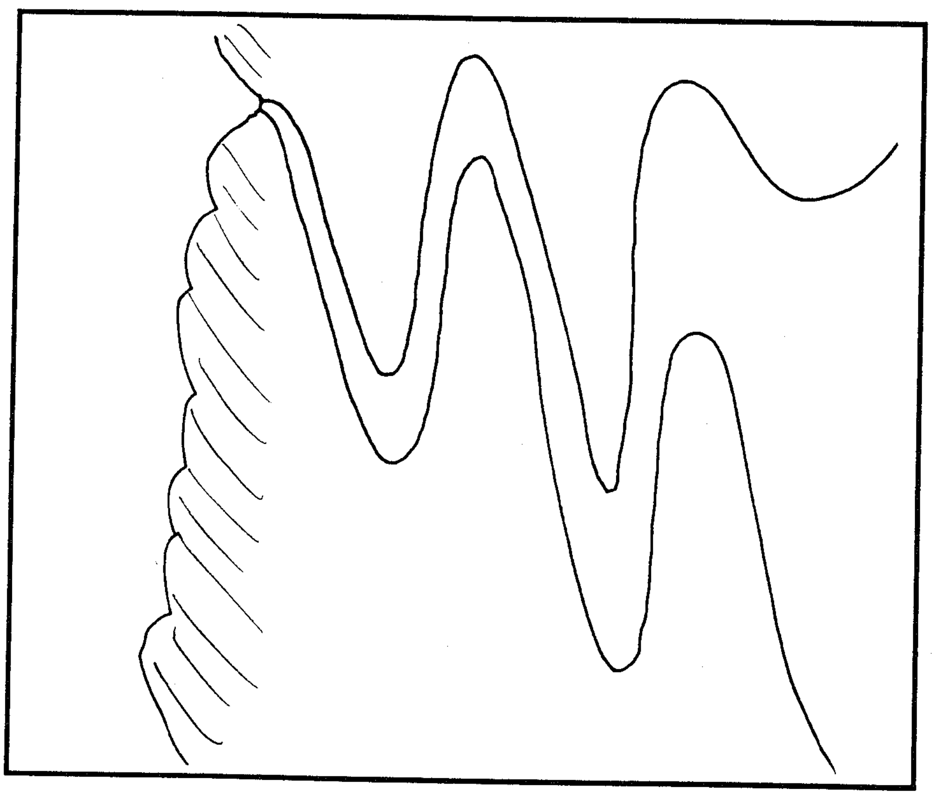
KALSADA PAPUNTONG KAGUBATAN



DA'AN PADULAON SA KAKAHUYAN

FOREST ROADS

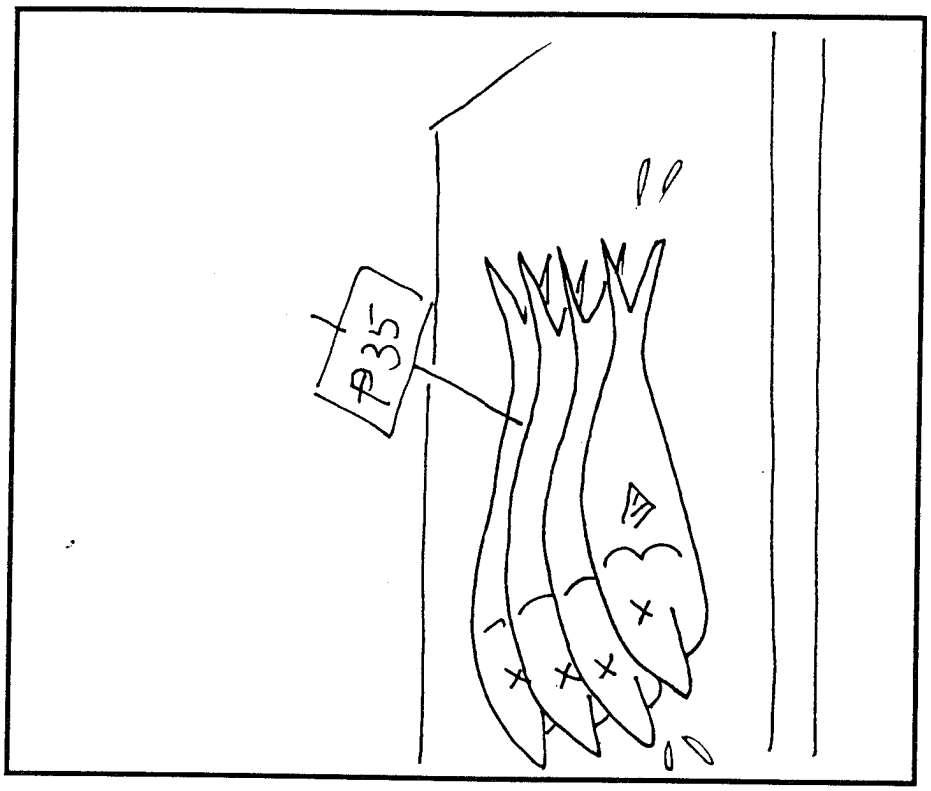
ILOG



SAPA

RIVER

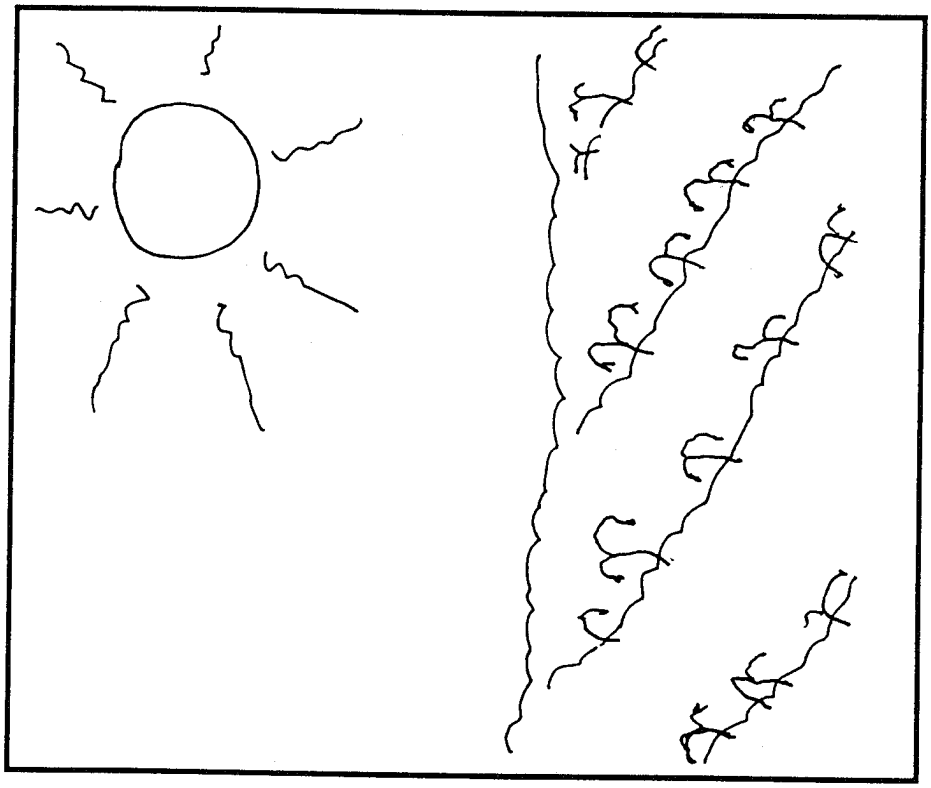
PRESYO NG ISDA



PRESYO SA ISDA

PRICE OF FISH

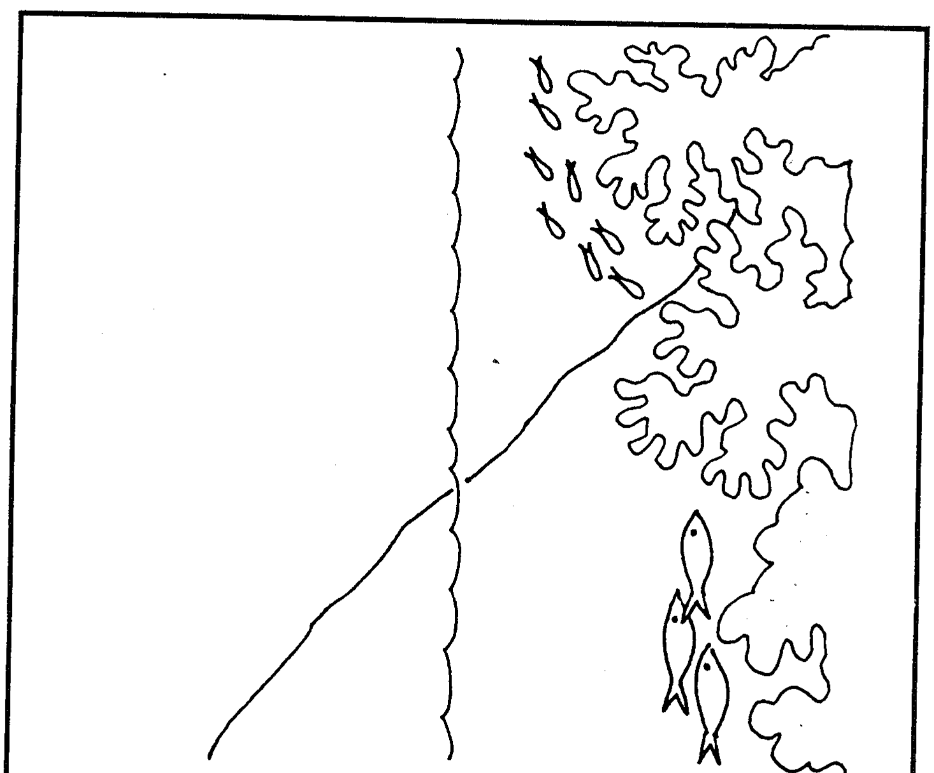
SOBRONG TAG-INIT



HUWAN

DROUGHT

THE CORAL REEF



THE CORAL REEF

THE CORAL REEF

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